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CHEMISTRY AND CANADIAN AGRICULTURE[1]

To me has been accorded the honor of participating in the welcome which is being offered to the members of this society at this, their first, meeting on Canadian soil. At any time and under ordinary circumstances it would have afforded me—as indeed any citizen of Canada—very great pleasure to give you a hearty greeting. Your presence here is evidence of the goodwill and friendly feeling that exist between the chemists of the United States and those of Canada, and we are proud to have gathered here in convention representatives of that great chemical body that includes in its membership men from all parts of the North American continent. Chemists, I have always believed, are to be numbered among the men whose work makes for the welfare of their country and they know no political boundary lines in the giving out of the results of their labors. I know that we in Canada have benefited largely by the work of the chemists of the experiment stations in the United States.

But the pleasure of having you here and in some small way reciprocating the favors you have so often showered upon us is enhanced in the great satisfaction we feel that you should visit the Dominion at a time when our country is so prosperous. At no previous stage in its history has there been the same substantial, steady progress and

[1] Address of the chairman of the Section of Agricultural Chemistry at the Toronto meeting of the American Chemical Society, June 27, 1907.

development that has marked the past five years. In agriculture, in all industries and manufactures, in mining, in exports and we may say in all those things which we believe conduce to a country's prosperity, we are to-day in an enviable condition. Nor have we as yet reached the high-water mark. We believe that we have only entered upon an era of "good times." The prospects for the future are bright and the signs of the times indicate that for some years there will be a steady advance—an ever-increasing development of the many great natural resources we possess. In all this I know you will rejoice with us.

And having said this, the question will naturally arise in your minds: What is the secret, the reason for this phenomenal development? My answer is that it is due, chiefly, to a better, more thorough realization by ourselves and those of other countries, of the great agricultural possibilities of this Dominion. We have in our northwestern provinces alone unmeasured, almost illimitable, areas of the most fertile soil, yet awaiting the plough—soil rich and deep, a veritable mine of plant food, chemically and physically perfect and specially adapted, so far as we can judge under the climatic conditions that prevail, for the production of the finest quality of the most important, the most valuable of all food-stuffs—wheat. While we recognize the value of all her other natural resources, Canada is, and will probably always remain, essentially an agricultural—a food-producing—country, capable, as the years go by, of sustaining an immense population and giving a large surplus of food-stuffs for export.

It is not my purpose to make this address a statistical record, but in order to give you proof that I have not spoken in exaggerated terms regarding this truly astounding development I must give you a few figures kindly furnished to me by the Dominion Census Office. They refer to the northwestern provinces, Manitoba, Saskatchewan and Alberta.

	Population	Cereals	
		Acres	Bushels
1900	419,512[2]	3,491,414	43,251,662
1905	808,863[3]	6,025,190	162,244,929
1906		7,894,666	239,841,001

These data need little comment. They furnish evidence of the most satisfactory character respecting our growth as a whole and of the rapid extension of agriculture in the Northwest, particularly. May I quote in this connection the concluding sentence of the Report of the Select Committee on Agriculture and Colonization of the House of Commons, 1906–7?

> A careful survey of the entire field demonstrates that agriculture, the cornerstone of national wealth and power, is in a more prosperous condition at present in Canada than in any other country of the world, while the yet unmeasured territory of rich virgin lands awaits settlement ready to respond bounteously to the industry and intelligence of many millions of willing hands. In a word, Canada is the world's greatest bread field of the day.

If time permitted I should have liked to tell you something of the agriculture, the various soils and climatic conditions characterizing the different provinces as we travel across the Dominion from the Atlantic to the Pacific. There would be much of interest to the agricultural chemist in such a study. But such a recount, even in the briefest form, is now impossible. Every province has its own advantages, but it also has its own peculiar problems to solve. No doubt you already know something of the farming conditions in eastern Canada, which was first to be settled; of the Garden of the Gulf, Prince Edward Island, that has recently been brought to realize the

[2] Population on April 1, 1901.
[3] Population on June 24, 1906.

extent to which she has impoverished her soils by continued cropping with potatoes and oats and who now is endeavoring to restore lost fertility by the development of dairying and the more extensive growth of clover; of Nova Scotia and her world-famous orchards in the valleys of the Annapolis and Cornwallis, her dyked lands which she shares with her sister province, New Brunswick, and from which hay has been cut for many a decade without apparent deterioration of the soil; of the picturesque province of Quebec, on either side of the St. Lawrence, peopled for the most part by the thrifty "habitant" who has tilled faithfully, if at times not over-wisely, the land that has descended from father to son for many a generation; of the banner province of Canada, Ontario, with her strong, productive soils, her immense wealth in live stock, her splendidly developed dairying industry, her cereals and fruits.

Again, in the West there is the province of the Pacific coast, British Columbia, as yet but sparsely settled, where mining and lumbering are more important industries to-day than agriculture, but which nevertheless is daily gaining prominence from the great success that has attended fruit growing within her confines. This industry is still in its infancy, but already the Okanagan, the Kootenay and other similarly situated districts in the semi-arid belt of the interior are exporting large amounts of fruits of the finest quality to the settlers of the northwest provinces.

It is to these latter, comprising Manitoba, Saskatchewan and Alberta, that we now turn our attention, though I can only give you the merest outline of them and their possibilities. The cry for some years past, and still is to-day, "Westward, ho!" People are going in, one might say rushing in, to possess and to till these vast, fertile western plains. The first to enter in and to possess this great lone country were farmers from Ontario and eastern Canada. Of late years, however, while the exodus from the east has continued, these provinces have received thousands from Great Britain, northern Europe and lastly we have welcomed from the great republic south of us, and more particularly from the northwestern states, large numbers of experienced farmers. This area in the west, containing probably more than 170,000,000 acres of arable land, is being fast occupied by an industrious, intelligent, law-abiding people—a progressive, ambitious people, imbued with the spirit of the west, who are not content merely with the methods that satisfied a past generation, but who are anxious, as far as may be possible, to farm their land according to the principles of modern, economic agriculture. Our room for expansion will be evident from the consideration of the following estimates collated from official sources by Dr. Wm. Saunders, director of the Dominion Experimental Farms, and given by him in a paper on "Wheat Growing in Canada," in 1904. Dr. Saunders, I may add, has always been considered as a well-informed and most conservative authority in his statements regarding agricultural matters:

Land fit for settlement in western Canada (Manitoba, Saskatchewan and Alberta): 171,000,000 acres, of which there is now under cultivation 5,000,000 acres.

Present production of wheat and other grains, about 125,000,000 bushels.

Possible wheat production (one fourth under crop annually), 800,000,000 bushels.

With these facts before you it will not be surprising to learn that the past two decades have witnessed great activity on the part of our governments, both federal and provincial, in providing means and establishing machinery for education in farming matters, for the solution of such agricultural problems as require scientific re-

search, and for giving assistance in such ways as may be practicable to the individual farmer in his every-day work. The Ontario Agricultural College at Guelph, instituted in the seventies, has earned a continental reputation for the excellence of the training given her students, now to be found on farms and in technical positions all over the land. A large amount of very valuable experimental work has also been done at Guelph and, through the cooperative society of her graduates, in various parts of the province of Ontario. The system of farmers' institutes has been a further means of disseminating the principles of modern agriculture in the various provinces, chiefly by lectures and addresses, and also to some extent by practical demonstrations in the field. Manitoba and the maritime provinces within the past three years have established agricultural colleges which, besides doing strictly collegiate work, are fast becoming active centers for the propagation of agricultural knowledge.

It is just twenty years ago since the federal government established the Experimental Farm system, comprising at that time a central institution at Ottawa with a scientific staff and laboratories, and four branch farms, located, respectively, at Nappan (Nova Scotia), Brandon (Manitoba), Indian Head (N. W. T.) and Agassiz (British Columbia). Quite recently two others have been added to this list, at Lethbridge, southern Alberta, and Lacombe, northern Alberta. The immediate establishment of others, both in the east and in the west is under contemplation by the government.

It would be altogether too long a story to tell you, even in outline, of the experimental work done in the various branches of agriculture during these years by the experimental farms, in stock-feeding, in dairying, in soil management, in the growth of crops, in the use of manures, in the originating and distributing new and improved cereals and roots, in orchard work, in disseminating information relating to the prevention of insect and fungous pests. But is it not all recorded in the reports and bulletins of the farm, no doubt to be found on the shelves of your libraries?

I must not, however, omit to say that there is a very large amount of work done which finds but little permanent record. The experimental farms are not only for research and experimentation, but for the dissemination of information on agricultural matters generally. We have endeavored to make each farm, and especially the central farm at Ottawa, a bureau to which all engaged in farming should feel themselves at liberty to apply for advice and instruction. To this end the privilege of sending letters to the central farm, Ottawa, free of postage was extended by the government and has been largely used. The experimental farm undoubtedly exerts an influence of great practical value through this correspondence, the magnitude of which will be apparent when I tell you that from the central farm alone in the neighborhood of 35,000 letters are sent out annually in addition to reports, bulletins and other printed matter. This branch of the work has served to keep the farm officers in touch with the farmers in all parts of the Dominion. Further, it has brought to our notice many difficulties which have subsequently furnished most interesting subjects for research and we can point to many valuable results to the country at large that have arisen in the first place from a farmer's inquiry.

But it is of the chemical work more particularly that I am to speak to-day. Agriculture is not a branch of chemistry, but it is, nevertheless, to-day a vocation which calls for the intelligent application of principles based on chemical truths. Physics and

biology are sciences that also supply fundamentals, but all must agree that of these three, chemistry takes the first place, furnishing, as it does, the very foundation and framework of modern agriculture. It seems to be the science which above all others we fall back upon for an explanation of all agricultural operations, whether performed by nature or by man. We have not tried to make our farmers chemists, but in the presentation of chemical information relating to farm work (put as far as possible into language understandable to the layman) we have endeavored to make it clear that profitable agriculture to-day means putting into practise the teachings of the laboratory and the experimental plot; and I am happy to say that in this our labors have not altogether been in vain. Looking over the country as a whole and comparing the sentiment of our farming community of twenty years ago with that of to-day, I am well satisfied that good progress has been made in establishing a confidence in, and in awakening an appreciative attitude towards, scientific research and teaching.

Since among the factors that conduce to profitable farming, a productive soil is perhaps the one of greatest importance, it was only natural that from the outset we should have made the matter of the economic maintenance and increase of soil fertility our special study. As I have already told you, we have in certain parts of the older districts of the Dominion soils which have been partially exhausted by irrational and wasteful methods; and again, as you know, we have vast areas in the west, as yet practically untouched, of virgin soil of the finest quality, capable of producing magnificent crops. For the former we have endeavored to devise practical methods that would restore fertility—and this in a large measure without recourse to commercial fertilizers; for the latter we are trying to construct a plan or system of farming that would materially lessen the deterioration consequent upon exclusive grain farming.

In the course of this work during the past twenty years we have examined chemically several hundreds of surface soils representative of cultivated and virgin areas, and collected in every province of the Dominion. Many of these have been submitted to what we might term complete soil analysis, including the determination of available plant food by the Dyer method. Physical determinations, in a large number of instances, have been obtained to supplement the chemical data. With these results at hand and with conclusions we have been able to draw during this period from personal observation and inspection of soils in various parts of Canada, it might naturally be expected that we should be in a position to make some pronouncement regarding fundamental differences that might exist between fertile virgin soils and unproductive, worn soils, respecting the factors that go to make up what we might term fertility, and their relative importance. With regard to these factors, we may say that our work, in accordance with that of many others, has shown that, apart from climatic conditions (temperatures, rainfall, sunshine, etc.) soil-productiveness results from a happy assembling of the chemical constituents of plant food in more or less assimilable forms, of physical properties allowing of soil aeration, the retention of moisture, and the providing of freedom for root extension, and, lastly, the presence of an abundance of those microorganisms which, living on the organic matter of the soil, prepare the nourishment of our farm crops. It is thus seen that, according to our present views, the three sciences, chemistry, physics and biology, must all contribute

their share of work towards a complete and correct soil diagnosis. We can not stay now to consider how far our methods today are satisfactory towards that end; we all admit they are far from perfect. Nevertheless, there has been a marked advance during the past ten years, and there are at the present time earnest and skilful workers engaged in this research whose labors are yearly adding to our store of knowledge on this important but exceedingly difficult and complicated subject.

Our own work in this matter has been more particularly in tracing the relation of organic matter and its concomitant, nitrogen, to crop-producing power.

1. Very early in our soil studies I was impressed by the fact that our virgin soils of great productiveness were invariably characterized by large percentages of organic matter and nitrogen, and that, on the other hand, worn soils resulting from continuous grain growing or other irrational systems, and soils from naturally poor areas, showed meagre amounts of these constituents. If we except soils from the semi-arid districts of the west, and the muck soils of the east, these statements will apply, more or less strictly, to all types of soils, from heavy clays to light sandy loams.

2. We found, further, that in those soils from humid districts there was a relationship between the organic matter and the nitrogen—that what affected or destroyed the former dissipated the latter; while, on the other hand, the methods that led to an increase of the organic matter also raised the nitrogen content. Undoubtedly these two constituents stand and fall together.

3. Another feature of importance was that accompanying a fair organic content there was usually a goodly proportion of available phosphoric acid, potash and lime: that is, according to the Dyer method of determination.

4. Lastly, it was evident that the proportion of organic matter present influenced in a marked degree the capacity of the soil for holding moisture, and in several other important particulars affected the mechanical condition.

We have not been able to study the effect of the organic matter and nitrogen content on bacterial life, but I believe it will be shown that, other conditions being equal, there is a distinct relationship between these important factors, the latter being determined by the former. Further, that fertility will be found largely dependent upon the rate of nitrification during the growing season, which, though largely regulated by temperature and moisture, must be materially affected by the amount of the food supply that the microorganisms find in the form of partially decomposed nitrogenous organic matter.

Another matter closely connected with nitrification is the liberation in available forms of mineral plant food. Is it not more than probable that the two processes are coexistent and interdependent—possibly identical?

As the years went by and our data increased it became ever more and more plain that in the semi-decomposed organic matter and its nitrogen we had factors of primary importance and of the greatest diagnostic value—that from them we could obtain a fairly clear insight into the character of the soil—chemical, physical and biological.

Since, then, we have reason to believe that the percentage of nitrogen is directly and indirectly a measure of the soil's fertility, and that this percentage is largely influenced by the treatment the soil receives, we may consider the data from one or two series of experiments to show the rate of

depletion of soil nitrogen under certain conditions of farming, on the one hand, and, on the other, the extent to which nitrogen enrichment may take place when nitrogenous organic matter is allowed to decay in the soil.

To procure figures that would illustrate the injurious effect on soils by continued grain growing interspersed with fallowing, we obtained from our Experimental Farm at Indian Head, Sask., in 1905, a sample collected from an area that had been broken in 1882 and that had between that date and 1905 borne six crops of wheat, four of barley, and three of oats, with a fallow between each crop since 1887, nine fallows in all. No manure or fertilizer had ever been applied.

HISTORY OF CULTIVATED SOIL

1883, wheat,	1890, fallow.	1898, fallow.
1884, wheat.	1891, barley.	1899, wheat.
1885, wheat.	1892, fallow.	1900, fallow.
1886, barley.	1893, wheat.	1901, oats.
1887, wheat.	1894, fallow.	1902, fallow.
1888, fallow.	1895, oats.	1903, barley.
1889, oats.	1896, fallow.	1904, fallow.
	1897, barley.	

For comparison, a sample of soil was taken from an adjacent area that had never been cultivated, the point of collection being about 120 feet away from where the cultivated soil samples were taken. Each sample was, of course, of a composite nature. There is every reason to believe that the soil over the whole area was originally of an extremely uniform nature and with a similar nitrogen content throughout.

Samples were taken representative of the first four and eight inches, respectively, and the nitrogen results, calculated to the water-free soil, are as follows:

In this comparison I am obliged to assume that the virgin soil is no richer to-day in nitrogen than it was twenty-two

DEPLETION OF SOIL NITROGEN

Nitrogen Content of Virgin and Cultivated Soils, Indian Head, Sask.

	To a Depth of 4 Inches		To a Depth of 8 Inches	
	Per Cent.	Lbs. per Acre	Per Cent.	Lbs. per Acre
Virgin soil.	.409	3824	.371	6936
Cultivated soil.	.257	2402	.253	4730
Difference or loss due to removal in crops and to cultural methods.	.152	1422	.118	2206

years ago. This is not, of course, strictly correct, for we must suppose that this prairie soil with its annual crop of grass would year by year increase its nitrogen content. The increase, however, we think, could not be such as to materially affect the significance of the above figures.

The loss of nitrogen consequent upon this style of farming is seen to be enormous. It presents an aspect of western farming of a most serious character. Yet there has not been, so far as we can judge, any marked diminution in the yield during this period; provided climatic conditions are favorable, it is held that this cultivated soil will give as fine a crop as it did twenty years ago. The reason is that there is in this soil to-day in spite of its losses a nitrogen content about twice that considered necessary to the production of a maximum crop—it was one of the richest soils; it still is one of exceptional fertility. In such a matter as this chemistry is as a watchman upon the tower warning us of trouble that is yet afar off and which we still have time to avert; interrogating the soil by pot culture, so much favored by some, would be of no value in announcing the fact that most disastrous losses are taking place.

The next enquiry in this soil study is, what proportion of this loss may be due to removal by crops, what proportion to cultural operations? To answer this we

have calculated the nitrogen contained in the various grain crops produced, and find that from this cause there has been removed during this period, approximately, 694 pounds per acre. If we subtract this amount from the total loss, calculated to a depth of eight inches of soil, we shall see that more than twice as much nitrogen has been dissipated by our methods of cultivation than is removed in the crops. The loss ordinarily in the grain growing districts of the west would not in all probability be as great as that here recorded, because as a rule the land is fallowed every third year only, and not every other year, as with the soil under discussion. Nevertheless, the deterioration must be marked and I fear unless checked the experience of the extreme east may be at no very distant date that of the west. It seems to me incumbent upon us at once to seek for methods that are less wasteful—we must introduce a crop for the west as we already have for the east, occasionally, or better still systematically, as in a rotation, that will keep up the store of organic matter and nitrogen.

The natural means for replenishing the soil with these organic constitutents is of course farm manures, but unfortunately in the districts where such are most required the supply is frequently inadequate. We, therefore, at once fall back upon the leguminosæ—the nitrogen gatherers. These are nature's soil enrichers. We know of no other family of plants that can be used on the farm possessing the unique and valuable property of appropriating the free nitrogen of the air—nitrogen which may be subsequently made available for succeeding crops. Not that the fertilizing value of the legumes lies simply and solely in the nitrogen they contain, though therein is their chief merit; the large quantity of humus-forming material they furnish, the mineral matter—potash, phosphoric acid, and lime—set free in their decomposition, are features the significance of which, I think, has been somewhat overlooked. It is, however, simply from the standpoint of nitrogen that I shall present certain data at the present time. They will serve to illustrate the three methods we have employed to demonstrate the manurial value of clover and other legumes, viz.: by analysis of the legumes, by estimation of the nitrogen in the soil before sowing the legume and after its decomposition, and by determining the yields of various farm crops following this use of the legumes.

NITROGEN CONTENT OF VARIOUS LEGUMES

There are presented in the following table data showing the weight of crop and nitrogen per acre furnished by eight of the more common legumes, the determinations being made on the foliage (stems and leaves) and roots (collected to a depth of nine inches), respectively.

Of course, no attempt will be made to say what proportion of this nitrogen was obtained through the agency of the nitrogen-fixing bacteria, but of the strong probability that the greater part was from the atmosphere we have, I think, good evidence in the fact that all these legumes were well provided with nodules on their roots, and also that there is, all things considered, a remarkable agreement between these figures and the increase in soil nitrogen due to the decomposition of the legume crop.

Further, I wish you to consider these results as merely indicative—the amount of nitrogen appropriated and available for manurial purpose would undoubtedly be influenced, within certain limits, by the character of the soil, the prevalence of the nitrogen-fixing bacteria and the nature of the season. In this matter I have been in the

NITROGEN IN VARIOUS LEGUMES

Legumes: One Season's Growth	Weight of Crop per Acre		Per Cent. of Moisture	Nitrogen	
	Tons	Lbs.		Per Cent.	Pounds per Acre
Clover:					
Common red, stems and leaves.	4	1,779	76.24	.920	90
Roots.	2	1,445	71.22	.881	48
Total.	7	1,224			138
Clover:					
Mammoth red, stems and leaves.	6	1,310	79.13	.616	82
Roots.	3	1,260	77.57	.661	48
Total.	10	2,570			130
Clover:					
Crimson, stems and leaves.	11	234	83.32	.382	85
Roots.	3	201	83.87	.304	19
Total.	14	435			104
Alfalfa:					
Stems and leaves.	5	1,192	71.63	.670	75
Roots.	5	558	64.74	.577	61
Total.	10	1,750			136
Hairy Vetch:					
Stems and leaves.	11	1,895	82.78	.544	129
Roots.	2	345	86.35	.414	18
Total.	14	240			147
Soja Beans:					
Stems and leaves.	7	350	74.69	.571	82
Roots.	1	900	80.12	.448	13
Total.	8	1,250			95
Horse Beans:					
Stems and leaves.	7	733	84.04	.429	63
Roots.	2	852	86.72	.308	15
Total.	9	1,585			78
Pease:					
Stems and leaves.	12	1,013	86.56	.476	119
Roots.	1	1,132	84.94	.328	10
Total.	14	145			129

habit of telling our farmers that in the growth of red clover which takes place after the harvesting of the cereal crop and before the season closes (in eastern Canada we advocate sowing eight to ten pounds of red clover seed with all classes of cereals) there should be in the neighborhood of one hundred pounds nitrogen per acre—that is, provided growth has not been retarded by a period of drought. The ploughing under of this crop, either in the late autumn or the following spring, according to the nature of the next crop to be planted, is now a system widely adopted with excellent results.

Though we have shown conclusively that clover can be successfully grown at many points in Manitoba and Saskatchewan, there is not in many parts of these provinces a sufficiency of moisture during the growing season for both clover and grain crops. Further, the severity of the winter is such as to render doubtful the survival of the clover. Therefore, while advocating clover wherever its growth is possible, we have looked about for a legume that would better fulfill the requirements of the case, that would allow the fallowing of the land, say, till the middle of June, to get rid of weeds, and then, being sown, would in two months give such a growth for turning under as to make it of practical value. We think we have such a legume in pease, data regarding which from two months' growth are given in the table. Though the root system is not extensive, it will be seen that by plowing under the whole crop we can enrich the soil by, approximately, two tons of humus-forming material per acre containing in the neighborhood of 130 pounds of nitrogen.

INCREASE OF SOIL NITROGEN DUE TO GROWTH OF LEGUMES

For a number of years we have been endeavoring to determine directly, that is, by analysis of the soil, the amount of nitrogen derived from the growth of a leguminous crop. I may very briefly describe one of the experiments in this series and which, begun in 1902, is still in progress. A plot 16 feet by 4 feet was staked off and the sides protected by boards sunk to a depth of eight inches. The surface soil to this depth

was then removed and in its place a strictly homogeneous but very poor sandy loam substituted—the nitrogen content of which was .0437 per cent. This was dressed with the following chemical fertilizer:

Superphosphate at the rate of....400 lbs. per acre.
Muriate of potash at the rate of 200 lbs. per acre.

It was then sown with red clover, May 13, 1902. During each succeeding season the growth has been cut twice, and the material allowed to decay on the soil. At the end of every second season the crop has been turned under, the soil being stirred to a depth of approximately four inches, and the plot resown the following spring. From the subjoined table, it will be seen, four collections and analyses of this soil have been made since the experiment began, and each successive collection has shown a marked increase in nitrogen—an increase which I think very satisfactory for such an open, sandy soil.

NITROGEN-ENRICHMENT OF SOILS DUE TO GROWTH OF CLOVER

	Date of Collection	Nitrogen	
		Percentage in Water-free Soil	Pounds Per Acre to a Depth of 4 Inches
Before experiment.	13–5–02	.0437	533
After two years.	14–5–04	.0580	708
After four years.[4]	15–5–06	.0608	742
After five years.	30–5–07	.0689	841
Increase in nitrogen due to five years' growth of clover.		.0252	308

In two seasons we enriched this soil in nitrogen to the amount of 175 pounds per acre; in five years, despite losses, the land is richer by 308 pounds per acre.

EVIDENCE OF SOIL ENRICHMENT FROM SUBSEQUENT CROP YIELDS

To conduct experiments in the field to prove that the growth of clover has a beneficial influence upon succeeding crops might seem to some as superfluous and unnecessary. The knowledge of the value of clover in this particular is truly a matter of ancient history. Nevertheless, to bring home in a very practical way to the Canadian farmer the fact that he could find in clover and other legumes the very cheapest and best of manures, and to show that our laboratory results would receive confirmatory evidence in the field, we instituted several series of experiments on the Dominion Experimental Farms in the growing of various crops after clover. I shall only present data from two series, but they are typical and may, therefore, very well serve to illustrate the results we have obtained regarding the after-effect of the legume. Each series consisting of two plots, one with and one without clover, was continued for three seasons after the growth of the clover and it will be noticed that there was an increased yield from the plots that had carried the clover—right to the end of the experiment period. The increases are truly phenomenal. All our results have been of an equally convincing nature and it seems almost impossible to comment upon the data without appearing to use extravagant language regarding this method of green manuring. I will, therefore, let the figures tell their own story.

This table requires but a word of explanation. The plots in each series are contiguous, the soil uniform in character with the same history and of an open, sandy nature. In series I. the clover was sown without any nurse crop, one cutting made and removed; in series II. oats were sown with the clover and no cutting of the latter made. In each case the clover was turned under in the following spring.

Perhaps I may have already overstepped the bounds set me and encroached on the valuable time of this convention. I am

[4] The season of 1905 was an exceedingly poor one for clover and the growth on the plot was consequently very meager.

INCREASE OF CROP DUE TO GROWTH OF CLOVER

1900	1901			1902			1903		
		Tons	Lbs.		Bush.	Lbs.		Tons	Lbs.
Series I: Plot A: Clover.	Corn	27	1760	Oats	75	10	Sugar beats	22	600
Plot B: Wheat.	"	19	1280	"	51	26	" "	8	1,260
Increase due to clover.	Corn	8	480	Oats	23	18	Sugar beats	13	1,400
1901	1902			1903			1904		
Series II: Plot A: Oats with clover.	Corn	20	600	Potatoes	202		Barley	Bush. 45	Lbs.
Plot B: Oats.	"	15		"	154	40	"	38	16
Increase due to clover.	Corn	5	600	"	47	20	Barley	6	20

anxious not to sin in such a serious matter and, therefore, I will ask you to take this chapter as giving an example of the way in which we have approached some of the fundamental problems in Canadian agriculture. To review, even in a similarly sketchy manner, our work during the past twenty years for the various branches—stock feeding, dairying, fruit growing, etc.—would be now quite impossible. Investigations that occupy several years, such as, for instance, the one undertaken to learn the effect of different feeding stuffs on the quality of the pork produced and in which the fat from more than 300 pigs was analyzed, can not be summarized in a sentence or two. Of a similarly protracted character have been the experiments to ascertain the losses that take place in the preservation of barnyard manure, in winter and summer; of experiments with various cultures or preparations of nitrogen-fixing bacteria—a matter that has engaged our attention since 1897 owing to its relationship to the maintenance of soil fertility through the leguminosæ; of experimental work carried on in different parts of the Dominion to determine how far soil moisture can be controlled by various systems of soil managements, more particularly in orchards; of reclamation work on swamp muck soils, of which there are large areas in eastern Canada as well as in British Columbia. Then, again, chemical work has been brought into requisition for determining the relative value of Canadian forage crops—grasses, Indian corn, rape, etc., and the period in their growth at which they are most nutritious; for the examination of sugar beets in connection with the establishment in Canada of the beet sugar industry; for tracing the effect of environment and cross-breeding on the composition of wheats, with a view to assisting in the discrimination between the many wheats produced by hybridization—a work that has largely received the attention of the experimental farms. And so I might continue, for our field of operations has been a wide one and we have endeavored to make the chemical work useful to as large a number as possible. Perhaps a thought that has been uppermost in my mind, and in the minds of others engaged in this work from the beginning, is that while all our investigations should be conducted with the spirit of true scientific research they should be undertaken as far as possible with a definite, practical purpose in view. So that while our work, I hope, rings true, judged from the chemical standpoint, it may also be accounted of some practical worth to that national industry for the assistance of which our institutions were established. The motto of the Royal Agricultural Society of England, "Practise with Science," always

had a certain charm for me. The principle here expressed applied to our work might be interpreted, "Utility with Research." We have not, so far as I am aware, made any discoveries that will revolutionize the agricultural world, nor have we been looking for such; we have endeavored to do the work that came to our hands faithfully and with such skill as we possessed. Our results may not have been made the subjects of magazine articles, nor heralded in the public press under sensational head-lines, but we have the greater satisfaction of knowing that they have been helpful to the Canadian farmer. There is so much work to be done that one feels at times as if a beginning had not yet been made; nevertheless, on looking back it is not difficult to see wherein chemical research has played its part in the development of Canadian agriculture.

May I, in conclusion, say that our work in agricultural chemistry has been very greatly assisted by help in various ways from those in charge of the chemical investigations at the experiment stations in the United States? Many of our problems have been yours. You were the pioneers in the field; we have profited much by your work and experience. We acknowledge with gratitude our indebtedness, and trust that the friendly relations that have so far existed between us may always continue; and that we may always be able to work together, recognizing that our object is one and the same—the progress of agriculture on the North American continent.

Frank T. Shutt
Dominion Experiment Farm,
Ottawa, Can.

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

For the tenth consecutive year we publish statistics in regard to the degrees of doctor of philosophy and doctor of science conferred by the universities of the United States. The total number of doctorates conferred was 327, almost exactly the same as in 1905 and 1906, when the numbers were, respectively, 325 and 326. The average number for the past ten years has been 271. There has thus been an increase, though probably not so large as in the number of positions to be filled. It must also be remembered that the number of American students receiving degrees from foreign universities is probably less now than it was ten years ago.

TABLE I.

DOCTORATES CONFERRED

	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	Total
Chicago	36	24	37	36	27	32	36	44	31	53	356
Harvard	26	24	36	29	31	28	46	38	46	34	338
Columbia	22	33	21	25	32	39	29	38	42	41	322
Yale	34	30	26	39	29	36	39	34	29	22	318
Johns Hopkins	33	38	33	30	17	23	31	35	32	33	305
Pennsylvania	24	20	15	25	14	29	18	26	28	26	225
Cornell	19	7	19	21	23	20	13	21	19	19	181
Clark	12	5	9	7	1	4	10	18	13	8	87
Wisconsin	5	6	5	6	11	4	12	9	9	19	86
Michigan	7	4	5	3	10	10	8	7	8	7	69
New York	5	9	7	6	4	4	9	7	9	7	67
Boston	0	0	0	0	0	4	7	14	10	9	44
California	1	3	2	2	1	3	3	4	9	5	33
Virginia	0	2	2	8	6	3	1	1	0	5	28
George Washington	1	0	5	3	2	4	3	3	2	5	28
Princeton	0	3	3	3	1	1	2	5	5	3	26
Minnesota	1	2	3	2	3	3	3	3	2	2	24
Brown	1	3	3	2	2	5	0	2	1	4	23
Bryn Mawr	3	3	1	2	2	0	5	2	2	1	21
Nebraska	2	1	1	1	0	0	2	3	7	3	20
Catholic	1	0	0	0	2	2	5	1	5	4	20
Stanford	2	0	2	2	2	1	1	1	2	1	14
Iowa	0	0	0	0	0	2	0	2	5	2	11
Georgetown	0	0	0	0	0	3	1	2	0	4	10
Washington	0	2	0	1	0	1	1	0	2	0	7
Vanderbilt	0	0	3	1	0	0	0	0	1	1	6
Colorado	0	1	0	0	0	0	2	0	2	0	5
Illinois	0	0	0	0	0	0	0	1	3	1	5
North Carolina	0	0	0	0	2	1	0	1	0	1	5
Missouri	0	1	0	0	0	0	0	2	0	1	4
Northwestern	1	1	0	1	0	0	0	0	0	1	4
Wash. and Lee	0	0	0	0	1	0	1	0	1	1	4
Cincinnati	0	0	0	0	0	1	1	1	0	0	3
Kansas	0	1	0	0	0	2	0	0	0	0	3
Lafayette	0	0	0	0	0	3	0	0	0	0	3
Massachusetts Inst.	0	0	0	0	0	0	0	0	0	3	3
Lehigh	0	0	0	0	0	2	0	0	0	0	2
Syracuse	0	1	0	0	1	0	0	0	0	0	2
Dartmouth	0	0	0	0	0	0	0	0	1	0	1
Tulane	0	0	1	0	0	0	0	0	0	0	1
Western of Pa.	0	0	0	0	0	0	0	0	0	1	1
	236	224	239	255	224	270	289	325	326	327	2,715

Chicago awarded last year 53 degrees, which is the largest number conferred so far by a single institution. This makes the total number of degrees conferred by Chi-

cago larger than the number conferred by Harvard, which latter institution last year stood at the head of the list. Then follow Columbia, Yale, Johns Hopkins, and, with much larger breaks, Pennsylvania and Cornell. There is then a drop to institutions that during the past ten years have conferred less than a hundred degrees—Clark, Wisconsin, Michigan and New York. Those that have conferred less than fifty degrees are headed by Boston and California. This year Chicago and Columbia conferred more than the average number of degrees, while Yale conferred fewer than usual. The most interesting change is the giving by Wisconsin of nineteen degrees, more than twice the average number for the past ten years. This places Wisconsin considerably in advance of Michigan, while among the state universities these two institutions form a separate class.

Table II. gives a comparison of the total number of graduate students and the number of doctorates conferred by nineteen of the leading institutions. The number of graduate students is taken from the statistics compiled by Professor Tombo and printed in SCIENCE. The registration in the graduate schools of these universities was 4,073 and the number of degrees conferred was 283, only about 7 per cent. It thus appears that a comparatively small proportion of the graduate students in our universities take the doctor's degree. A large number go to the universities with only the master's degree in view, and their academic work is regarded as complete when this degree has been received. There are also many students who devote only part of their time to graduate work, and these remain a good many years as graduate students, and often in the end do not take the degree.

TABLE II.

	Registration in Graduate Schools 1906–1907	Doctorates Conferred in 1907	Per Cent.	Average Number Doctorates Conferred Annually 1898–1907	Per Cent.
Johns Hopkins..	156	33	21	31	20
Virginia..	43	5	12	3	7
Chicago	358	53	15	36	10
Cornell	212	19	9	18	8
Pennsylvania.....	285	26	9	23	8
Harvard	437	34	8	34	8
Michigan.....	96	7	7	7	7
Wisconsin.....	302	19	6	9	3
Yale.....	357	22	6	32	9
Columbia.....	808	41	5	32	4
Minnesota.....	53	2	4	2	4
Nebraska.....	95	3	3	2	2
New York.....	222	7	3	7	3
Northwestern.....	40	1	3	½	1
Princeton	110	3	3	3	3
California.....	204	5	2	3	1
Stanford	49	1	2	1	2
Missouri	107	1	1	½	½
Illinois.....	139	1	1	1	1
Total	4,073	283	7		

The institutions are arranged in the order of the percentage of graduate students who received degrees last year, and the differences are very striking. As the number of degrees conferred in a single year is subject to considerable chance variations, there is also given a comparison of the average number of degrees conferred during the past ten years with the registration for last year, data in regard to the average registration for the past ten years not being available. The Johns Hopkins has by far the best record, one fifth of its graduate students taking the degree each year. Chicago stands next, with one seventh this year and an average of over one tenth. Harvard, Yale, Pennsylvania and Cornell give the degree each year to 8 or 9 per cent. of their graduate students, Columbia to only 5 per cent.

If these results were due to a severe natural selection and the degree was given to the men who are most likely to contribute to the advancement of science and learning, there would be no ground for regret. But it is by no means certain that this is

the case, or that those who received the degree of doctor of philosophy were of greater average ability or better average training than graduates in medicine or law. The supply of men for academic positions and for positions in the government service and other places where the ability to conduct independent research should be a requisite is inadequate, and it is to be feared that it does not represent the intellectual aristocracy of the nation.

Table III. shows the number of degrees conferred in the sciences enumerated in

TABLE III.

DOCTORATES CONFERRED IN THE SCIENCES

	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	Total	Per Cent.
Hopkins	19	17	20	19	9	10	17	18	18	21	168	55
Chicago	12	11	16	14	13	21	14	21	14	28	164	46
Harvard	11	7	15	15	14	15	23	12	17	12	141	42
Columbia	10	19	10	11	14	15	11	13	16	15	134	42
Yale	11	14	9	18	10	13	15	13	15	6	124	40
Cornell	11	2	10	13	16	13	8	13	7	11	104	57
Penna.	8	7	5	12	5	13	9	12	11	8	90	40
Clark	12	5	6	6	1	4	10	18	9	6	77	89
Wisconsin	2	4	1	3	2	0	4	3	2	7	28	33
Michigan	0	3	1	0	5	4	6	?	5	4	28	41
California	1	3	1	2	1	3	2	3	3	5	24	73
Geo. Wash.	1	0	3	1	1	4	0	3	2	2	17	60
Nebraska	2	1	1	1	0	0	1	2	3	2	13	65
Brown	1	0	0	1	2	4	0	2	1	1	12	52
Stanford	2	0	0	1	2	1	1	1	2	1	11	78
Princeton	0	3	1	0	0	1	1	3	0	2	11	42
Virginia	0	2	0	4	1	2	0	0	0	2	11	39
Bryn Mawr	1	2	1	2	1	0	2	0	1	0	10	48
Iowa	0	0	0	0	0	1	0	2	3	1	7	64
Minnesota	0	0	1	0	1	1	0	1	1	2	7	29
Washington	0	2	0	1	0	1	1	0	2	0	7	100
New York	1	1	0	1	0	0	1	1	1	0	6	9
Catholic	0	0	0	0	1	2	1	0	0	1	5	25
Illinois	0	0	0	0	0	0	0	0	2	1	3	60
Kansas	0	1	0	0	0	2	0	0	0	0	3	100
Mass. Inst.	0	0	0	0	0	0	0	0	0	3	3	100
Missouri	0	1	0	0	0	0	0	1	0	1	3	75
N. Carolina	0	0	0	0	2	1	0	0	0	0	3	60
Vanderbilt	0	0	1	1	0	0	0	0	1	0	3	50
Wash. & Lee	0	0	0	0	1	0	1	0	1	0	3	75
Colorado	0	0	0	0	0	0	0	0	2	0	2	40
Lehigh	0	0	0	0	0	2	0	0	0	0	2	100
Northwestern	0	1	0	1	0	0	0	0	0	0	2	50
Boston	0	0	0	0	0	0	0	0	0	1	1	2
Cincinnati	0	0	0	0	0	0	0	1	1	0	1	100
Dartmouth	0	0	0	0	0	0	0	0	1	0	1	33
Georgetown	0	0	0	0	0	0	1	0	0	0	1	10
Lafayette	0	0	0	0	0	1	0	0	0	0	1	33
Syracuse	0	0	0	0	1	0	0	0	0	0	1	50
Total	105	106	102	127	103	134	129	143	140	143	1232	45

Table IV. Of 2,715 degrees conferred during the past ten years, 1,232, somewhat less than half, have been in the natural and exact sciences. The relative proportion of degrees in the humanities and in the sciences has not altered appreciably in the ten years covered by these statistics. The Johns Hopkins has conferred more degrees in the sciences than any other institution, but is closely followed by Chicago and at a not very considerable distance by Harvard, Columbia and Yale. Fifty-five per cent. of the degrees conferred at the Johns Hopkins have been in the sciences, and 57 per cent. at Cornell, whereas in the other leading institutions the percentage is decidedly less—46 at Chicago, 42 at Harvard and Columbia and 40 at Yale and Pennsylvania. It is rather surprising to note that at Wisconsin only one third of the degrees are in the sciences. At California and Stanford, where the numbers are, however, too few to give reliable figures, the percentages are 73 and 78.

Table IV. gives the degrees conferred in each of the sciences. Chemistry, as always, leads with about the usual number of degrees. There is an increase this year in the number of degrees in physics and zoology, 22 and 18, respectively, and a decrease in the number in psychology to 10. In previous years sociology and education

TABLE IV.

DOCTORATES CONFERRED IN THE SCIENCES

	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	Total
Chemistry	27	32	26	28	27	33	35	36	38	38	320
Physics	11	7	15	24	12	14	17	14	19	22	155
Zoology	12	11	11	15	16	12	15	15	22	18	147
Psychology	18	15	9	13	8	18	10	21	12	10	134
Botany	11	11	12	8	12	9	17	15	16	15	126
Mathematics	11	13	11	18	8	7	13	20	9	11	121
Geology	6	5	5	10	6	10	7	4	11	7	71
Physiology	4	1	4	1	8	8	1	3	3	8	41
Astronomy	3	2	4	5	2	4	4	3	4	3	34
Paleontology	0	4	2	1	0	2	2	3	2	0	16
Bacteriology	0	1	1	1	1	3	3	0	1	3	14
Anthropology	2	0	2	1	0	1	2	1	0	1	10
Agriculture	0	0	0	0	2	2	2	2	0	2	10
Anatomy	0	1	0	1	0	4	0	0	0	3	9
Engineering	0	0	0	1	0	3	1	3	0	0	8
Mineralogy	0	2	0	0	1	1	0	1	1	0	6
Pathology	0	0	0	0	0	3	0	0	1	1	5
Metallurgy	0	0	0	0	0	0	0	1	1	1	3
Geography	0	0	0	0	0	0	0	1	0	0	1
Meteorology	0	1	0	0	0	0	0	0	0	0	1
Total	105	106	102	127	103	134	129	143	140	143	1232

have been included among the sciences, when the work of the candidates was supposed to be inductive or statistical in character. But it is not possible, with the information at hand, to discriminate between work that is scientific and work that is historical or literary, and the degrees in sociology and education have this year been eliminated from the table.

The institutions that conferred three degrees or more in special subjects are as follows: *Chicago,* chemistry 5, zoology 3, botany 4, mathematics 4, physiology 4; *Columbia,* chemistry 5; *Cornell,* chemistry 4; *Harvard,* zoology 3, psychology 3; *Johns Hopkins,* chemistry 11, physics 3; *Massachusetts Institute of Technology,* chemistry 3; *Pennsylvania,* physics 4; *Yale,* chemistry 3.

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

UNIVERSITY OF CHICAGO

George David Birkhoff: "Asymptotic Properties of Certain Ordinary Differential Equations with Applications to Boundary Value and Expansion Problems."

William Richards Blair: "The Index of Refraction of Water for Electric Waves by Interference Methods."

Roy Hutchison Brownlee: "On Precipitated Sulphur."

Stephen Reid Capps, Jr.: "The Pleistocene Geology of the Leadville Quadrangle, Colorado."

Charles MacDonald Carson: "A Study of the Equilibrium Relations of $S\lambda$ and $S\mu$."

Rollin Thomas Chamberlin: "The Gases occluded in Rocks."

William Crocker: "The Rôle of Seed in Delayed Germination."

Edna Daisy Day: "The Digestibility of Starch as affected by Cooking."

Emil Goettsch: "The Nature, Structure and Distribution of the Œsophageal Glands of Mammals."

Lawrence Emery Gurney: "The Viscosity of Water at Low Rates of Shear."

Charles Claude Guthrie: "The Relation of Pressure in the Coronary Vessels to the Activity of the Isolated Heart and Some Closely Related Problems."

Paul Gustav Heinemann: "The Kinds of Bacteria concerned in the Natural Souring of Milk."

Willis Stose Hilpert: "The Stereoisomerism of Nitrogen Compounds: Stereoisomeric Chlorimido Esters."

Hemming Gerhard Jensen: "Toxic Limits and Stimulation Effects of Some Salts and Poisons on Wheat."

James Wright Lawrie: "The Chemistry of the Acetylidene Compounds."

Hugh McGuigan: "Oxidations of Various Sugars in the Animal Body."

Andrew Fridley McLeod: "On Aldol, Pentarrythrose and the Action of Copper Acetate on the Hexoses."

Arthur Ranum: "On a New Kind of Congruence Groups."

Oscar Riddle: "The Genesis of Fault-bars in Feathers and the Cause of Alternation of Light and Dark Fundamental Bars."

Gustav Ferdinand Ruediger: "The Mechanism of Streptococcus Immunity."

Victor Ernest Shelford: "The Life-histories and Larval Habits of the Tiger Beetles."

Frances Grace Smith: "Morphology of the Trunk and Development of the Microsporangium of Cycads."

John Sundwall: "The Structure of the Lacrymal Gland."

Reinhardt Thiessen: "The Vascular Anatomy of the Seedling of Dioon."

Charles Henry Turner: "The Homing of Ants: An Experimental Study of Ant Behavior."

Anthony Lispenard Underhill: "Invariants under Point Transformations in the Calculus of Variations."

Buzz M. Walker: "On the Resolution of Higher Singularities of Algebraic Curves into Ordinary Double Points."

Shigeo Yamanouchi: "A Study of Apogamy."

JOHNS HOPKINS UNIVERSITY

John August Anderson: "Absorption and Emission Spectra of Neodymium and Erbium Compounds."

Clyde Shepherd Atchison: "Curves with a Directrix."

Frederick Conrad Blanck: "The Nitration of Aniline and Certain of its Derivatives."

Taylor Scott Carter: "The Fluorescence, Ab-

sorption and Magnetic Rotation Spectra of Potassium Vapor."

Frank Lawrence Cooper: "Measurements of Wave-lengths of the Spark Spectra of Chromium, Manganese and Calcium; also of the Arc Spectra of Cerium and Thorium; together with a Study of the possible Influence of Variations of Current, Capacity, etc., in the Spark Circuit."

Paul Brown Dunbar: "The Osmotic Pressure of Cane Sugar Solutions in the Vicinity of 4° Centigrade."

William Davis Furry: "The Epistemological Use of the Esthetic Consciousness."

William West Holland: "The Osmotic Pressure of Cane Sugar Solutions in the Vicinity of the Freezing Point of Water."

Harry Nichols Holmes: "Electric Osmose."

Aubrey Edward Landry: "A Geometrical Interpretation of Binary Syzygies."

Benjamin Franklin Lovelace: "The Osmotic Pressure of Glucose Solutions."

Bartgis McGlone: "Notes on the Anatomy and Life-history of *Moira Atropos*."

Daniel Webster Ohern: "The Trilobita, Mollusca and Echinodermata of the Paleodevonian of Maryland."

James Newton Pearce: "Dissociation as measured by the Freezing-point Lowering and by Conductivity-bearing on the Hydrate Theory. The Composition of the Hydrates formed by a Number of Electrolytes."

Francis Mitchell Rogers: I. "The Osmotic Pressure of Glucose Solutions in the Vicinity of the Freezing-point of Water." II. "The Use of Weight-normal Solutions in the Measurement of Osmotic Pressure."

William Henry Schultz: "The Effect of Chloralhydrate upon the Properties of Heart-muscle."

Guy Howard Shadinger: I. "On the Affinity Constants and Constitution of several Urazoles." II. "On the Velocity Constants of the Reactions between Alkyl Halides and Urazoles."

Lloyd William Stephenson: "The Mesozoic Deposits of the Coastal Plain of North Carolina."

Charles Milton Stine: "The Effect of one Salt on the Hydrating Power of another Salt present in the same Solution."

William Reed Veazey: "The Conductivity and Viscosity of Solutions of certain Salts in Water, Methyl Alcohol, Ethyl Alcohol, Acetone, Nitrobenzene and Binary Mixtures of these Solvents."

Leon Franklin Williams: I. "A Study of the Action of Primary, Secondary and Tertiary Amines on Camphoroxalic Acid." II. "Acyl Derivatives of Ortho- and Paraminophenol."

COLUMBIA UNIVERSITY

Henry Kreitzer Benson: "On the Use of Molten Salts containing Water of Crystallization as Solvents."

William Nathan Berg: "The Digestibility of Various Proteins in Solutions of the same Acids."

Louis Jacob Cohen: "Some New Double Phosphates."

William Klaber: "On Certain 7-nitro-4-quinazolones."

Elsie Kupfer: "Studies in Plant Regeneration."

Albert Buell Lewis: "Tribes of the Columbia Valley."

Abram Lipsky: "Rhythm as a Distinguishing Characteristic of Prose Style."

Robert Cecil McMahon: "Technical History of the White Lecythi."

John Maurice Nelson: "Some Compounds derived from Succinylosuccinic Ester."

Raemer Rex Renshaw: "4-aminophthalic Acid and some of its Derivatives."

William Carl Ruediger: "The Field of Distinct Vision."

Charles H. Shamel: "Geology in the Law."

Charles Rupert Stockard: "The Development of the Mouth and Gills in Bdellostoma Stanti."

George Booker Waterhouse: "The Influence of Nickel and Carbon in Iron and the Overheating, Burning and Restoring of Nickel Steel."

Anne Sewell Young: "The Stellar Clusters h and χ Persei; Measurement and Reduction of the Rutherford Photographs."

HARVARD UNIVERSITY

John Mead Adams: "The Transmission of Röntgen Rays through Metallic Sheets."

Arthur Mangun Banta: "A Comparison of the Reactions of a Species of Terranean with those of a Species of Subterranean Isopod."

Marshall Albert Barber: "On Heredity in certain Microorganisms."

Charles Scott Berry: "An Experimental Study of Imitation in Animals."

William Charles Brenke: "A Contribution to the Theory of Trigonometric and Zonal Harmonic Series."

Herbert Spencer Davis: "Spermatogenesis in Acrididæ and Locustidæ."

Louville Eugene Emerson: "An Investigation in the Simultaneous Stimulation of Adjacent Touch Spots on the Skin."

Calvin Olin Esterly: "The Light-recipient Organs of the Copepod Eucalanus Elongatus."

Herman Brunswick Kipper: "Ketone Substitution Derivatives of Orthohydroxyketones, Alkali-insoluble Phenols."

Edward Mueller: "The Atomic Weights of Potassium and Chromium."

Ernest Linwood Walker: "The Parasitic Amœbæ of the Intestinal Tract of Man and other Animals."

Karl Tinsley Waugh: "The Rôle of Vision in the Mental Life of the Mouse."

CORNELL UNIVERSITY

John Eliot Coit: "The Cultivated Peony."

Thomas G. Delbridge: "Tetrachlorgallein and its Derivatives."

Philena Belle Fletcher: "The Bees of the Cayuga Fauna."

Lee Fred Hawley: "Contributions to the Chemistry of Thallium II."

John Peter Magnusson: "Equilibrium between Hydrogen Sulphide and Ammonia."

Frank Curry Mathers: "A Study of the Atomic Weight of Indium."

Richard Morris: "On the Automorphic Functions of the Group $(O, 3; l_1, l_2, l_3)$."

Elsie Murray: "Organic Sensation."

Charles Smith Prosser: "The Classification and Distribution of the Series of Central and Eastern New York."

Effie Alberta Read: "A Contribution to the Knowledge of the Olfactory Apparatus in Dog, Cat and Man."

Francis Robert Sharpe: "The General Circulation of the Atmosphere."

UNIVERSITY OF PENNSYLVANIA

Harold Charles Barker: "Thermo-electromotive Forces of Potassium and Sodium with Platinum and Mercury."

Bertha May Clark: "On the Variation of the Heat of Mixture with Concentration and Temperature."

Charles Aaron Culver: "A Study of the Propagation and Interception of Energy in Wireless Telegraphy."

John Frazer: "The Application of the Rotating Anode to Certain Electrolytic Separations and an Investigation of the Electro-deposition of Indium with the Use of the Rotating Anode."

William Peter Haseman: "A Method for the Determination of the Optical Constants of Metals in the Infra-red."

Thomas Potter McCutcheon, Jr.: "New Results in Electro-analysis."

Mary Isabel Steele: "Regeneration in the Compound Eyes of Crustacea."

Frank Macy Surface: "The Early Development of a Polyclad, Planocera Inquilina, Wheeler."

UNIVERSITY OF WISCONSIN

Florence Eliza Allen: "On the Determination of Cyclic Involutions of Order Three."

William Ballantyne Anderson: "A Spectroscopic Study of the Spark Spectrum in Various Gases at High Pressure."

Lewis Fussell: "Self-excited Polyphase Asynchronous Generator."

William George Marquette: "Concerning the Organization of the Spore-mother-cells of *Marsilia quadrifolia*."

George Matthew Reed: "Injection Experiments with *Erysiphe cichoracearum* DC."

Frederick Lafayette Shinn: "On the Optical Rotatory Power of Salts in Dilute Solutions."

John Weinzirl: "The Action of Sunlight upon Bacteria with Special Reference to Tuberculosis."

CLARK UNIVERSITY

Horace Leslie Brittain: "A Study in Imagination."

William Franklin Copeland: "Periodicity in Spirogyra."

Oris Polk Dellinger: "Comparative Study of Cilia as a Key to the Structure of Contractile Protoplasm."

Tadasu Misawa: "A Sketch of the History of the Modern Philosophy of Education."

George Edwin Stebbins: "Sound Distortion by the Telephone Transmitter and Receiver."

William Edward Story, Jr.: "An Investigation on the Poulsen Arc in Wireless Telegraphy."

YALE UNIVERSITY

Henry H. Conover: "On Certain Problems in the Calculus of Variations."

Arthur Harmount Graves: "The Morphology of *Ruppia Maritima*."

William Barri Kirkham: "The Early Development of the Mammalian Egg."

Philip Henry Mitchell: "Purin Metabolism in the Embryo."

David Lindsey Randall: "The Use of Potassium Permanganate in the Estimation of Iron, Mercury and Molybdenum."

Tadasu Saiki: "The Chemistry of Non-striated Muscle."

UNIVERSITY OF CALIFORNIA

Benjamin Marshall Davis: "Early Life-history of *D. pusillus* Ritter."

Harvey Monroe Hall: "The Compositæ of Southern California."

James Davis Maddrill: "A Study of Several Stars of the Delta Cephei Type."

Thorburn Brailsford Robertson: I. "On the Conditions of Equilibrium of an Associating Amphoteric Electrolyte."

Charles Edwin Weaver: "Geology of the Napa Quadrangle, California."

UNIVERSITY OF MICHIGAN

Benjamin Franklin Bailey: "Induction Coils, an Experimental and Theoretical Research."

Calvin Henry Kauffman: "Contribution to the Physiology of Saprolegnia."

Frederick Arthur Osborn: "Change of Index of Refraction of Liquids with Temperature."

Donald Dexter Van Slyke: "Action of Molecular Silver, Silver Sulphate and Silver Chloride upon some Halogenated Triphenyl-carbinol-chlorides."

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Raymond Haskell: "The Effect of Concentration and Ionization on the Rates of Diffusion of Salts in Aqueous Solutions."

Robert Browning Sosman: "The Hydrolysis of Ammonium Acetate and the Ionization of Water at High Temperature."

Morris Archer Stewart: "The Dissociation Relations of Sulphuric Acid."

THE GEORGE WASHINGTON UNIVERSITY

Frederick Warren Grover: "The Simultaneous Measurement of the Capacity and Power Factor of Condensers."

Walter Otheman Snelling: "Contributions to the Study of Tellurium."

UNIVERSITY OF MINNESOTA

William Macdonald: "The Reclamation and Settlement of Arid Lands."

Anthony Zeleny: "The Capacity of the Mica Condenser and its Application as a Standard for the Comparison of Electrical Quantities."

UNIVERSITY OF NEBRASKA

Ruth Marshall: "The Arrhenuri of the United States."

Elda Rema Walker: "On the Structure of the Pistils of some Grasses."

PRINCETON UNIVERSITY

Claude Silbert Hudson: "The Forms of Milk-sugar."

Harvey Ernest Jordan: "The History of the Chromatin during the Early Stages in the Development of the Female Reproductive Cells of *Asterias Forbesii*."

UNIVERSITY OF VIRGINIA

Frank Walker Reed: "Singular Points in the Approximate Development of the Perturbative Function."

William Beverley Stone: "The Groups of Two, Three and Four Parameters of Space and their Differential Invariants."

BOSTON UNIVERSITY

William Robinson: "History of Automatic Electric and Electrically-controlled Fluid-pressure Signal Systems for Railroads."

BROWN UNIVERSITY

Victor Emmanuel Emmel: "Regeneration in *Homarus Americanus*."

CATHOLIC UNIVERSITY OF AMERICA

Thomas Frederic McKeon: "The Diurnal Variation of the Spontaneous Ionization of Air in Closed Metallic Vessels."

UNIVERSITY OF ILLINOIS

Edward Murray East: "A Study of the Factors influencing the Improvement of the Potato."

UNIVERSITY OF IOWA

George Cutler Fracker: "On the Transference of Training in Memory."

UNIVERSITY OF MISSOURI

Howard Sprague Reed: "The Value of Certain Nutritive Elements in the Plant Cell."

LELAND STANFORD JUNIOR UNIVERSITY

Harry Baker Humphrey: "Studies in the Morphology and Physiology of some California Hepaticæ."

SCIENTIFIC BOOKS

THE ANTARCTIC EXPEDITION OF THE "DISCOVERY," UNDER CAPT. SCOTT, R.N., 1901–1904

The National Antarctic Expedition, 1901–4. Natural History, Vol. II., Zoology (Vertebrata; Mollusca; Crustacea). London, The British Museum, 1907. 4°, 348 pp., 44 pl. Map and many illustrations in the text. Vol. III., Zoology and Botany (Invertebrata; Marine Algæ; Musci). 275 pp., 62 pl. 1907.

The British Museum having undertaken to publish and supervise the reports of the Antarctic Expedition under Capt. Scott, the two handsome and profusely illustrated volumes now under consideration comprise the first fruits of this arrangement. The Vertebrata are reported on by E. A. Wilson, W. P. Pycraft and G. A. Boulenger. Dr. W. G. Ridewood contributes an extensive memoir on *Cephalodiscus,* of which two new species were obtained. The Mollusca and Brachiopoda are treated by E. A. Smith, W. E. Hoyle and Sir Charles Eliot. W. T. Calman, A. O. Walker, G. S. Brady, Dr. Thiele and Professor Gruvel report on the Crustacea; L. V. Hodgson on the Pycnogonids; Dr. Trouessart on the Acari; Dr. Fowler on the Chætognatha; Dr. von Linstow on the Nematodes; and Mr. A. E. Shipley on the Cestodes. The Cœlenterates are treated by Messrs. Hickson, Gravely and Rennie; the sponges by R. Kirkpatrick. Mr. and Mrs. Gepp undertake the Marine Algæ except a new species of *Lithothamnion* which is described by M. Foslie; while the scanty flora of mosses is the subject of a discussion by J. Cardot.

Each memoir is separately paginated and there is no general index.

It is obvious that, within the space available, only a brief survey can be given of such an aggregation of short reports. Professor Herdman introduces volume III., by a ten-page report on methods of collecting in Antarctic seas, which is well worthy of attention from those whose fortune it may be to prepare for such work under analogous conditions. The peculiar difficulties, due to the extremely low temperatures encountered, are such as would often not be anticipated by collectors without experience in Polar seas, and offer an interesting field for experiment. It may be mentioned that the reviewer's experience in opening and keeping open holes in the ice at temperatures below minus 30° Fahr., leads to the belief that a soft iron or copper chisel of triangular section, hafted with a heavy pole of wood, is the most efficient. The extreme temperature seems to harden the soft metal sufficiently, without rendering it brittle as in the case of steel tools.

The reports on the marine mammals and birds are the most voluminous and contain perhaps the largest amount of material of general interest. The absence of the southern right whale from the icy seas is confirmed, but Mr. Wilson believes that Ross's report of its presence sixty years ago may, nevertheless, have been correct. The process of extermination of this species has been nearly successful, owing to the habit of whalers destroying the nursing young in order to secure the mother. The most common species are the finback, and a small Australian *Balæna,* but killers are plentiful and gregarious. A supposedly undescribed species of whale, with an extraordinarily long back fin, is illustrated and described, but not named, as is another probably new species of dolphin, resembling *Lagenorhynchus.*

The seals observed were the usual four Antarctic species, to which were added most unexpectedly a young male sea elephant, killed at McMurdo sound far from its usual haunts. Data are included on Hooker's sea lion which was studied at Laurie Harbor, Auckland Island *en route* to the Antarctic. All these animals are admirably illustrated by colored plates and sketches, as well as half-tone figures from photographs of the living animal.

Among Antarctic birds the penguins stand naturally preeminent, and the most remarkable of these is the great Emperor penguin, which attains a weight of ninety pounds. An extremely interesting account of the breeding habits of this species, hitherto hardly known, shows that it lays its single egg in the depth of

the southern winter. No nest is made, but the egg is held between the thighs of the parent, resting partly on the feet, enveloped by a loose fold of the abdominal integument, and pressed against a medial bare spot. The body temperature of the bird exceeds 100° Fahr., which is sufficient to incubate the egg during its long period of six or seven weeks.

When the mother bird feels the need of food she releases the egg, which is immediately seized by one of her associates, who broods it in the same manner. Thus a group of several birds cares for a single egg during the intense cold and darkness of the polar night. When the young is hatched the nestling continues to be brooded in the same way, and so eager are the birds to possess themselves of a young one that many of the chicks perish from the injuries sustained from the competing nurses. The young birds are fed by regurgitation. Eggs of this species, of which only a single specimen was previously known, are covered with a rough chalky layer and are of a pale green color, punctuated by numerous minute pores. The species lives entirely on the floe and pack ice. Their food appears to be chiefly crustacea, small fish and cuttlefishes, whose beaks, together with more or less gravel, are constantly found in the stomach. The other most familiar bird of the expedition was MacCormick's Skua, a bold and most persistent thief, one of which followed the sledge party to latitude 80° 20′ south, the only bird or beast met by the party during three months of solitude on the Polar ice cap. This species has the most southern range of any bird, and to the northward of the pack is replaced by the larger and darker-colored Antarctic Skua.

The fishes comprise ten species, mostly small, of which four are regarded as new.

The mollusks comprise about sixty species, about three fourths of which appear to be undescribed, the majority of which are small, dull-colored, and of the groups characteristic of Polar seas. Sir Charles Eliot finds two new genera, *Tritoniella* and *Galvinella,* among the Nudibranchs. Mr. Smith also reports two new genera among the Gastropods, *Neoconcha,* a peculiar Tænioglossate form, and *Trichoconcha,* which very closely resembles the Arctic *Torellia.* He also adds two new Brachiopods to the species already known, both belonging to the genus *Magellania.*

We have already alluded to the extensive memoir by Dr. Ridewood on *Cephalodiscus,* a genus related to *Rhabdopleura,* in which two new subgenera are instituted, and two new species described.

Two shrimps, both previously found by the German Polar Commission at South Georgia, and four species of Cumacea are added to the list of Antarctic crustacea. The collection of amphipods numbers fifty-three species, of forty-three genera, of which four genera and eighteen species are new to science. As in Arctic waters the Lysianassidæ preponderate. A single species of *Nebalia* is noted by Thiele and nine species of Ostracoda are enumerated by Brady, seven of which are new.

Two species of sessile barnacles occur, both previously known, and two new species of *Scalpellum.*

The *bizarre* animals belonging to the Pycnogonida were represented by a large collection, including three new genera and twenty-eight species, including the anomalous *Decolopoda* of Eights, described seventy years ago, and which has five pairs of legs; a fact of which naturalists were long incredulous. Why Eights's generic name is not retained Mr. Hodgson does not explain.

Two specimens of Halacaridæ were dredged in Granite Harbor, which Trouessart believes to be identical or only subspecifically distinct from *Halacarus alberti* of the Arctic.

The Alcyonaria presented few remarkable features. Several of the forms appeared like connecting links between others formerly separated, as *Primnoisis* and *Ceratoisis, Primnoella* and *Caligorgia.* A single specimen of Pennatulid, *Umbellula carpenteri,* first made known by the Challenger Expedition, was obtained off the great ice barrier. The hydroid zoophytes were well represented by twenty-five species, most of which are of epizoic habit and nearly all from McMurdo Sound.

The species of sponges are distributed as follows: Tetractinellid, four species; Monaxi-

nellid, forty-three species; and Calcarea, twenty-four species. There are no horny sponges, but some of the forms found were represented by a very large number of individuals. Of Hexactinellids there are ten species, all belonging to the Rossellidæ.

The number of marine algæ collected is but small, yet among them are some interesting novelties. The authors of the report upon them regard it as too early to attempt a comparison between the algoid floras of the Arctic and Antarctic. Some of the species are, however, certainly identical. A single species of *Lithothamnion* collected proves new. Seven species of mosses were found, bringing up to the number of fifty-one, the total of Antarctic species.

These volumes form an admirable addition to our knowledge of Antarctica, and will prove a lasting monument to the energy and devotion of those who constituted the little band of explorers in this, the most dreary and inhospitable region of the entire globe.

W. H. DALL

SCIENTIFIC JOURNALS AND ARTICLES

University of California Publications in Zoology, Vol. 3, is made up in large part of "Contributions from the San Diego Marine Laboratory." It includes several papers of a faunistic nature with descriptions of many new species from the pelagic fauna of the San Diego Region; on the littoral and pelagic Ostracoda and on the Cladocera by Chancey Juday, on the Copepoda by C. O. Esterly and on the Dinoflagellata by C. A. Kofoid. A list of "The Marine Fishes of Southern California," by E. C. Starks and E. L. Morris contains notes on the œcology and distribution of 246 species. A paper by H. B. Torrey on the California Shore Anemone (*Bunodactis xanthogrammica*) discusses the synonymy and occurrence of a widely distributed anemone. Mr. C. O. Esterly in "Some Observations on the Nervous System of Copepoda" describes the innervation of the æsthetasks of Copepod antennæ and ascribes a sensory function to the rostral prongs of *Diaptomus* and to certain furcal bristles of *Cyclops*, but finds no sensory nerve supply to the so-called tactile bristles of the antennæ. "A Discussion of Species Characters in *Triposolenia*," a group of bizarre organisms belonging to the Dinoflagellates, by C. A. Kofoid, calls attention to the "unit" nature of specific characters, to their non-adaptive significance, to the coincident distribution of related species and to the support which these facts lend to the Mutation Theory. The same author finds in a second paper on "The Significance of the Asymmetry of *Triposolenia*," that this is an adaptive structure which presents against the action of gravity the maximum vertical projection of the body on sinking and therefore delays descent from the illuminated upper strata of water to abyssal regions. In a paper by H. B. Torrey and Ann Martin on "Sexual Dimorphism in *Aglaophenia*" definite structural differences are shown to exist between the corbulæ of male and female colonies in the four California species. In each species, the leaflets of the male corbulæ are less completely fused than in the female, leading to a readily recognizable dimorphism. The purpose of "Biological Studies on Corymorpha, II., The Development of *C. palma* from the Egg" by H. B. Torrey was to discover (1) to what extent the form of the species might be determined by its activities, and (2) to compare the normal embryonic processes with those which appear in the regenerative development. The embryonic development is characterized by the plasticity of the tissues. The regions of the body, the tentacles, frustules, peripheral canals, axial endoderm, are molded largely out of more or less differentiated epithelial tissues without recourse to residual cells. These plastic processes are accomplished by various mechanical factors, including absorption of water, osmotic pressure, and amœboid movement.

Terrestrial Magnetism and Atmospheric Electricity for March contains a portrait of Roald Amundsen, and the following articles: "Concerning Pulsations of Short Period in the Strength of the Earth's Magnetic Field," by H. Ebert; "Contribution to the Study of the Effects produced on the Magnetic Declina-

tion by the Total Solar Eclipse of August 30, 1905," by C. Nordmann; "Note on the Present Position of the Earth's Magnetic Axis derived from Declination Data alone," by W. van Bemmelen; "What is the Earth's Magnetic Axis and its Secular Motion?" by L. A. Bauer; "Sketch of Life and Work of Roald Amundsen"; Notes: "Progress Magnetic Survey Pacific Ocean" [illustrated], "Magnetic Work in Canada, Mexico and Central America," "Personalia"; "Recent Papers in Atmospheric Electricity by Lüdeling, Lutz, Benndorf, Wood and Campbell, and Rudolph," abstracted by P. H. Dike.

DISCUSSION AND CORRESPONDENCE

THE ADMINISTRATION OF THE U. S. GEOLOGICAL SURVEY

To the Editor of Science: May I ask for space in your columns for the enclosed letters, which seem to me to be of sufficient general interest to warrant their publication?

Very truly yours,

W. S. Tangier Smith

Los Gatos, California,
July 26, 1907

Reno, Nev., June 1, 1907.

To the Director
U. S. Geological Survey,
Washington, D. C.

Sir: I hereby tender my resignation as assistant geologist on the United States Geological Survey.

This action was fully determined upon over four years ago, but was delayed, at first, until I should have finished the work upon which I was then engaged, and, later, as a measure of self-protection while my report of that work was in the hands of the editorial staff. The reasons for my resignation now are the same which determined my original decision to leave the survey, having been merely strengthened by my experience in the interval. Aside from some personal considerations (which are not essential to the present statement), these reasons all have to do with the character and management of the organization as I have known it.

Not to enter into details, I merely wish to record here my protest not only against the prejudiced and arbitrary methods of the geologist in charge of geology, and the commercial spirit which has grown up under his administration, but also, and chiefly, against the bureaucratic policy inaugurated before that administration and under it developed to such an extent that, in my opinion, it calls for protest from every self-respecting scientist who comes in contact with the organization. This policy is based on the assumption that any persons who hold positions of administrative authority on the survey constitute, *ipso facto*, an infallible scientific tribunal, whose function it is to pass judgment on the work of all other scientists who may be their official subordinates, and to suppress all heresies. As opposed to this assumption, I desire here to reaffirm what I have repeatedly declared in my communications and correspondence with officials of the survey—my conviction of the inalienable right of every scientist to the free expression of his own opinion, and the individual responsibility for his own work, no matter what the auspices under which the work is done, or opinions published.

Very respectfully,

(Signed) W. S. Tangier Smith

Department of the Interior,
United States Geological Survey,
Washington, D. C., June 11, 1907.

Dr. W. S. Tangier Smith,
Reno, Nevada.

Sir: I have forwarded your resignation to the Secretary of the Interior and have recommended its acceptance.

I regret that you feel that a protest is necessary against the administration of this bureau. I believe that the misunderstanding on the part of yourself and other geologists who have presented similar protests comes from the fact that you fail to see that administrative authority carries responsibility. Thus it is that in the matter of publication it is not so much the desire of the administrative officers of the survey to constitute themselves into a scientific tribunal as to be true to their official oaths and administer the survey with due regard for the letter and spirit of the congressional enactments which provide for the continuance of this work. You and I as individual scientists may have personal opinions regarding scientific work, but as long as we are members of a government organization we must conform to the purpose of the appropriation under which our work is done. In short, when we become members of an organization which pays for our work, we surrender a certain part of the "inalienable right,"

as you term it, to the free expression of our own opinion.

Very respectfully,
(Signed) GEO. OTIS SMITH,
Director

LOS GATOS, CAL., July 17, 1907.

DR. GEO. OTIS SMITH,
Director.
U. S. Geological Survey,
Washington, D. C.

Sir: I am in receipt of your letter of June 11 acknowledging my resignation from the survey, and referring to the protest accompanying it. I had intended to write to you to assure you that nothing in that protest referred to you personally; but, from your last letter, I am sorry to learn that your attitude in the matter is apparently hopelessly opposed to mine.

You mention, somewhat vaguely, "administrative responsibility," "official oaths" and "congressional enactments." Now, in my conception, the supreme responsibility of the scientist is to discover the truth and to tell it, in accordance with the clearest vision vouchsafed him; and this responsibility can not be superseded by the demands of any administrative position nor abrogated by any official oath. As for the "letter and spirit of the congressional enactments," if these should ever happen to come into conflict with scientific truth (which does not seem to me a very probable contingency, so long as congress and the Geological Survey confine themselves to the accepted limits of their respective fields of work), I would venture to suggest that congressional enactments are more easily changed than the facts of the universe, and that it is not necessary, in the interest of the former, to suppress or falsify even an individual conception of the latter.

But you say that in joining the survey the individual surrenders a part of the "inalienable right" of the scientist. Here, apparently, is the crucial point of the whole discussion. If this were generally accepted as a basic principle of the survey, it could not long support the claim of being a scientific organization, for no scientist with the highest conception of his calling would ever voluntarily accept such conditions of service; and the organization would speedily become, what your principle would logically make it, an artificial structure of red tape, reared by "administrative responsibility" (which easily becomes a synonym for autocratic privilege) on the foundation of "congressional enactments," and inspired by nothing higher than the ambition to secure more appropriations. In contrast to this bureaucratic conception, let me quote President Eliot's words with reference to scientific investigators: "They must set their own standards of excellence; for society can not supply men capable of supervising, regulating or stimulating them. . . . The scientific investigator must be a law unto himself. The utmost that governments or universities can do for him is to provide suitable facilities and conditions for his work, and to watch for results."

Since your letter was written in your official capacity, I suppose that you will not object to its being published, together with mine, as a contribution to a discussion of general interest to the scientists of the country.

With sincere regret for the difference of opinion which has developed between us, I am

Very respectfully,
(Signed) W. S. TANGIER SMITH

TYPE OF THE GENUS ASTACUS

TO THE EDITOR OF SCIENCE: Within the last decade, a good deal of controversy has been engaged in anent the type of the crustacean genus *Astacus*. These differences of opinion have arisen owing to authors having disregarded Degeer 1778 ("Mem. Ins.," VII.), who fixed as type *A. fluviatilis* Fabr. (= *Cancer astacus* Linné).

G. W. KIRKALDY

SPECIAL ARTICLES

COLOR VARIETIES OF THE RABBIT AND OF OTHER RODENTS; THEIR ORIGIN AND INHERITANCE[1]

IN the issue of SCIENCE for January 25, 1907, I have shown that the agouti, or wild type of coat of the guinea-pig, results from the simultaneous presence of three factors, which are separately heritable unit characters, namely, black pigment, yellow pigment and a factor causing the two pigments to be disposed in bands. In uniformly colored (or self) varieties of the guinea-pig, at least one of these three factors is wanting. If the lacking factor is supplied by a cross with a variety which possesses it, then reversion is obtained, that is a return to the wild type of coat.

It is the purpose of the present note to

[1] Published by permission of the Carnegie Institution of Washington.

point out that the same general explanation which was given for the color varieties of the guinea-pig is applicable likewise to the rabbit, but with certain interesting differences.

The gray coat of wild rabbits contains (1) black pigment and (2) yellow pigment (3) arranged upon the hair in bands, most conspicuous of which is a subapical band of yellow. The belly and under surface of the tail are white, due to entire absence of pigment from the terminal portions of the hair in those body regions. Whenever in rabbits the fur above is barred, the belly and lower surface of the tail are white. Three separately heritable factors, which conform with Mendel's law of heredity, are involved in the gray coat. These are *B*, black pigment; *Y*, yellow pigment, and *A*, the barring arrangement of the pigments, which includes absence of pigment from the hair-tips of the belly, as already explained.

Color varieties other than gray lack one or more of these factors more or less completely.

Varieties which lack the factor *A* have unbarred hair, in which the black and yellow pigments are intimately mingled together. Several different shades of color are produced by such combinations of the two pigments, in different proportions. In *black* individuals black pigment is in excess, in *sooty yellow* individuals yellow pigment is in excess, in *blue* individuals the black pigment exists in a dilute form, while the yellow apparently remains scanty in amount. But all three varieties alike, namely, black, sooty yellow and blue, have unbarred hairs and lack the white belly and tail found in wild rabbits. What they all in common have lost, as compared with wild rabbits, is the barring factor, *A*.

Rabbits which retain this factor are readily recognized by the white belly and tail. Such of them as have little or no black pigment in their fur are known as *yellow;* such as have black pigment of the dilute sort found in blue individuals are known as *blue-gray,* and such as have abundant black pigment of the ordinary intense sort are known as *gray;* their coat corresponds in every respect with that of wild rabbits.

Accordingly we can recognize among rabbits two parallel series of color varieties, which differ only in this respect, that in one series the factor *A* is present, while in the other series it is absent.

COLOR VARIETIES OF THE RABBIT

Series 1	*Series 2*
Gray, *BYA*	Black, *BY*
Blue-gray, *B* (dilute) *YA*	Blue, *B* (dilute) *Y*
White-bellied yellow, *B* (traces only) *YA*	Sooty yellow, *B* (traces only) *Y*

Any member of series 1 is dominant in heredity over the corresponding member of series 2, as might be expected, since series 2 is derivable from series 1 by loss of a single unit-character, *A*.

Within series 1, gray is dominant over blue-gray as well as over white-bellied yellow, both these conditions being derivable from gray by modification of the black pigment, in one case in quality, in the other case in quantity.

Similar relations exist between the corresponding members of series 2, black being dominant over its derived conditions, blue and sooty yellow.

Knowing the unit-characters borne by each variety (its gametic formula), one can readily predict the result of crosses between the several varieties. Any cross which brings together the three factors, *B, Y* and *A,* will give reversion, *i. e.,* a return to the wild type of coat, gray.

Thus, grays are obtained from mating white-bellied yellow or blue-gray with black. White-bellied yellow mated with blue gives sometimes gray, sometimes blue-gray, depending on the quality of the black pigment transmitted (in traces) by the yellow parent.

Similarly, sooty yellow mated with blue-gray may give either gray or blue-gray. But a mating of sooty yellow with homozygous white-bellied yellow produces nothing but the last named sort, since the black pigment transmitted in traces only by both parents is insufficient in amount to produce the gray coat.

The foregoing statements apply, of course, only to crosses between homozygous individ-

uals of the varieties named. In accordance with the general principles of Mendelian inheritance, it is found in these two series that any variety, which contains a dominant character, may be, as regards that character, either homozygous or heterozygous. Thus, heterozygous gray animals might produce any of the forms included in either series; indeed, in our experiments, all the forms except blue were so obtained, and blues were obtained in the following generation from the blue-grays.

Blue-grays, bred *inter se,* may, when heterozygous, be expected to produce also blue, white-bellied yellow and sooty yellow; blacks may give blue, as well as sooty yellow; blues and white-bellied yellows may each give sooty yellow; but sooty yellow is apparently incapable of producing any other variety enumerated in either series; it is recessive with respect to those varieties.

Accordingly, as regards breeding capacity (*i. e.,* gametic formula), we may distinguish six different sorts of gray rabbits, three of black ones, three of blue-gray ones, two each of white-bellied yellow and blue ones, but of sooty yellow one sort only, if we disregard qualitative differences in the traces of black pigment borne by sooty yellow individuals. An enumeration follows of these various sorts of individuals, most of which, as will be seen, have already been identified. In the enumeration, *B* will be used for black pigment, *B′* for the same in minute quantities only, *Y* for yellow pigment and *A* for the barring factor.

Gray

1. *BYA* · *BYA* breeds true. Found in wild rabbits and in the "Belgian hare" used in our experiments.

2. *BYA* · *BY* gives also black. This condition is often found in Belgian hares supposed to be pure, but really not pure as regards color characters. Produced in our experiments.

3. *BYA* · *B* (dilute) *YA* should give only gray and blue-gray. Not certainly known.

4. *BYA* · *B* (dilute) *Y* gives, in addition to gray, black, blue-gray and blue. Observed except as regards the productior of blue young; observations not very extensive.

5. *BYA* · *B′YA* gives, in addition to gray, white-bellied yellow only. Observed.

6. *BYA* · *B′Y* gives, in addition to gray, black, white-bellied yellow and sooty yellow. Observed.

Black

1. *BY* · *BY* breeds true. Known to exist.

2. *BY* · *B* (dilute) *Y* gives black and blue. Observed.

3. *BY* · *B′Y* gives black and sooty yellow. Observed.

Blue-Gray

1. *B* (dilute) *YA* · *B* (dilute) *YA* should breed true. Not yet obtained.

2. *B* (dilute) *YA* · *B* (dilute) *Y* gives also blue. Observed.

3. *B* (dilute) *YA* · *B′Y* should give blue-gray, blue, white-bellied yellow and sooty yellow. Not observed.

White-bellied Yellow

1. *B′YA* · *B′YA* breeds true. Observed.

2. *B′YA* · *B′Y* gives white-bellied yellow and sooty yellow. Observed.

Blue

1. *B* (dilute) *Y* · *B* (dilute) *Y* should breed true. Not yet certainly known.

2. *B* (dilute) *Y* · *B′* (dilute) *Y* gives blue and sooty yellow. Observed.

Sooty Yellow

B′Y · *B′Y* breeds true, so far as tested.

All of the numerous color varieties mentioned have arisen by *loss,* partial or complete, of one or more of the three independent factors which contribute to the production of the gray coat of wild rabbits.

It may be of interest to compare with the case of the rabbit, the evolution of color varieties among guinea-pigs, mice and rats, which, like the rabbit, are rodents more or less completely domesticated.

The agouti (or wild) type of coat of the guinea-pig is produced by the same three factors as the gray coat of rabbits, *viz.,* black pigment (*B*), yellow pigment (*Y*), and a barring factor (*A*). But in guinea-pigs there occurs also a third pigment of a chocolate-brown color, which is usually associated with black pigment, but has in recent years been obtained entirely separate from black pigment in the variety known as "chocolate." For this factor of the pigmented coat we may use the symbol *Br,* signifying brown. The homozygous color varieties of the guinea-pig may then be designated as follows:

COLOR VARIETIES OF THE GUINEA-PIG

Series 1	*Series 2*
Agouti, *BBrYA*.	Black, *BBrY*, Chocolate, *BrY*.
Yellow (black-eyed), *YA* (*BBr* in eyes and skin only), gives agouti in crosses with black.	Yellow (black-eyed), *Y* (*BBr* in eyes and skin only), does not give agouti in crosses with black. Yellow (brown-eyed), *Y* (*Br* in eyes and skin only).

As in rabbits, the color varieties fall into two parallel series, in one of which the factor *A* is present, while in the other it is wanting.

The chocolate variety was first obtained, in the experiments under discussion, from animals of other colors. Later, with the kindly assistance of Mr. Bateson, a chocolate male was obtained in England, where the variety has apparently originated recently. It is not mentioned by Cumberland (see bibliography) in his well-known work on the cavy.

The brown-eyed yellow variety I have obtained only recently in the second generation (F_2) from a cross between black-eyed yellow and chocolate. Its existence elsewhere is unknown to me.

We may confidently expect the production by appropriate matings of two varieties which will fall into series 1, opposite the newly obtained varieties of series 2, chocolate and brown-eyed yellow, from which varieties they will differ only by the addition of the factor, *A*.

The coat pigments of mice are similar to those of guinea-pigs, viz., black, brown and yellow. All three are probably present together in the coat of the gray house-mouse, along with a barring factor, *A*. Loss of *A* produces the black variety, precisely as in rabbits and guinea-pigs; loss of *B* produces the cinnamon agouti variety (a combination unknown as yet in guinea-pigs, as already stated); loss of both *B* and *A* produces, as in guinea-pigs, the chocolate variety. The yellow variety, we must believe, results from the suppression in the coat of both black and brown pigment, but this loss-condition, curiously enough, is dominant in crosses over the more inclusive combinations which contain *B* and *Br*.

Davenport (1904) and Cuénot (1905) have recorded observations upon yellow mice which manifestly bore the factor *A*, since they gave reversion in crosses with black and with chocolate individuals; but it is evident that the yellow mice used in my own experiments (Castle, 1906) lacked this factor completely, for neither grays nor cinnamon agoutis were obtained in crosses with black or with chocolate individuals. Further, Cuénot's black-eyed yellow mice were heterozygous, bearing black as a recessive character; my own, likewise heterozygous, so far as tested, bore in most cases chocolate as a recessive character. The yellow mice of Steer (mentioned by Bateson, 1903), which gave chocolate young, were evidently of this same sort. I have examined the eye pigments of one of the chocolate-producing yellow mice and find it to be brown, as in chocolate guinea-pigs, not black, as Cuénot states the eyes of his yellow mice to have been.

From these scattered observations we may infer that the gametic formula of yellow mice is varied; sometimes they lack *B*, sometimes they lack *A*, sometimes they lack both *B* and *A*; sometimes still other modifications seem to be involved which cause absence of pigmentation from the eyes, or eyes and belly both.

The wild rat doubtless has the same three factors involved in the production of its gray coat, as do the other rodents already discussed, those factors being *B*, *Y* and *A*; but the only one of these which has yet been lost so as to produce a self-colored variety is the barring factor, *A*. Loss of this produces the well-known black variety.

For the sake of simplicity, no reference has been made in the foregoing discussion to albino individuals, which may occur in any or all color-varieties. They are individuals which lack some *activating* substance necessary to make pigments visible. They carry color potentialities precisely as pigmented individuals do, as is clearly shown by the results of crosses between albinos and pigmented individuals. Further, they are differentiated,

precisely as pigmented individuals are, in respect to the intensities of the pigments transmitted, and even in respect to color-patterns (spotting and the like). All that the albino seems to lack in comparison with a pigmented animal, is an activating substance, and even this may be present in small amounts in the albino, as, for example, in the Himalayan rabbit and in the similar variety of the albino guinea-pig. My albino guinea-pigs of chocolate parentage have brown-pigmented extremities, those of black parentage have black pigmented extremities.

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W. E. CASTLE

ZOOLOGICAL LABORATORY,
HARVARD UNIVERSITY,
August 8, 1907

ASTRONOMICAL NOTES

THE ASTROGRAPHIC CATALOGUE

VOLUMES I. and II. of the Oxford Section of the Astrographic Catalogue, by Herbert Hall Turner, D.Sc., F.R.S., Savilian professor of astronomy, have recently been issued. The Oxford Section extends from Dec. $+24°$ to $+32°$.

The International Congress on Astronomical Photography met in Paris, in April, 1887. Oxford was one of the eighteen observatories which offered to take part in the mapping of the heavens by means of photographs. Two schemes of work were planned, each to cover the entire sky, one with short exposures of 6m, 3m and 20s, the other with exposures of about one hour. Twenty years have elapsed since that time. From Oxford we now have the two volumes above referred to, which are to be followed by six others. The whole bears witness to the ability and energy of the author and his assistants, and will no doubt prove of great value to astronomy. It also illustrates well the magnitude of the original schemes, which appear to have been unwisely large, since these eight volumes will complete only the study of the plates of short exposure. Professor Turner says:

> No attempt has, however, been made to take the long-exposure series at Oxford, as there has never been the least prospect of obtaining funds for publishing the charts, either at Oxford or at the majority of the participating observatories.

Evidently some decades must yet elapse before the completion of the original schemes, even if the need for their completion should remain urgent.

The Oxford plates were made by an instrument of the pattern proposed by the Henry Brothers, of Paris. It has an object-glass of 13 inches aperture, and a focal length of 11¼ feet, so that on the plates 1 mm. equals approximately 1′. The work was undertaken by the late Professor Prichard, but his death, at the advanced age of eighty-five years, took place before much had been accomplished. The catalogue gives the positions of the stars, expressed in rectangular coordinates, and the diameter of the stellar images, from which the magnitudes may be derived. In many cases it would be undesirable to use either of these quantities in the form here given. Tables are given, however, by means of which the rectangular coordinates may be converted into right ascensions and declinations. For the conversion of diameters into magnitudes, the formula is given: magnitude $= a - b\sqrt{d}$, where a and b are constants and d is the diameter of the image. This formula, as Professor Turner points out, introduces large errors for the faint stars. The precision of the positions is much more satisfactory, the

total probable error of a coordinate, made up of errors from all sources, being only 0."39. The number of stars measured in Volume I. is 65,750, and in Volume II., 66,718. Many of these are duplications, owing to the overlapping of the plates, but aside from this desirable duplication, the number of different stars measured in the whole Oxford section will be very great.

VARIABLE STARS

Two contributions to the subject of variable stars have recently appeared in the *Annals* of the Harvard College Observatory.

Volume XLVII., Part I., gives a detailed photographic study, by Mrs. W. P. Fleming, of the comparison stars for the 222 variables of long period, nearly all of which were discovered by her by means of their spectral peculiarities. No star having a spectrum of the class designated Md, that of the third type with the hydrogen lines bright, has yet been found which is not variable, although many stars having a different spectrum are also variables of long period. The present volume deals only with the identification, positions and magnitudes of the comparison stars. Rectangular coordinates, referred to the variable star as a center, are employed. The methods of measurement and reduction have been already explained in the *Annals*. At the time this work was undertaken no good method existed for the determination of photographic magnitudes. Those used in the present volume were derived from measurements of the stars with a scale having a series of images of different intensities. Each image, after the first, which had an exposure of one second, had an exposure three times as long as that of the preceding image. The intervals thus obtained are assumed to represent one magnitude. The magnitudes thus obtained are made to depend upon the visual magnitudes of the brighter stars of the sequence. This method furnishes a scale of magnitudes which, however large systematic errors it may contain, appears to be consistent within itself. Later, when the method which Professor Pickering has devised, or any other method for the determination of absolute photographic magnitudes, is available, systematic corrections can be applied to the values here given to reduce them to an absolute scale of magnitudes. A later volume will furnish a discussion of the observations of the variables themselves.

Volume LV., Part I., contains the Second Catalogue of Variable Stars, prepared by Miss A. J. Cannon. As explained by Miss Cannon, the history of variable star catalogues extends as far back as 1844, when a list of 18 variables appeared, compiled by Argelander. In successive lists the number of objects has increased since that time, at first slowly, but later with great rapidity through the introduction of photographic methods, until we come to the present catalogue, which contains 1,957 variables. This includes the 500 variables found in the globular clusters, but not the 1,800 found in the Magellanic clouds. Altogether, at the present time, about 3,750 stars are known to be variable, of which about 2,900 have been found at the Harvard Observatory. A study of the number and distribution of the variable stars over the whole sky seems now to be within reach. The present catalogue is the result of about ten years of compilation and observation. The foundation of a card catalogue of variable star literature was begun in 1897, by Professor W. M. Reed. This bibliography, carried forward by Miss Cannon, now consists of more than 35,000 cards. This vast amount of material, as well as much unpublished data belonging to the Harvard Observatory, has been used by Miss Cannon in making up the present volume. The main table gives, after the various designations of the star, and its position, the maximum and minimum magnitudes, the period when known, the epoch, class of variable, type of spectrum, provisional number in order of discovery assigned by Kreutz, and the date and name of the discoverer. Auxiliary tables and remarks give much information in regard to the peculiarities of many of the variables. Part II. of the same volume will contain further information, including a study of all the published maxima and minima of variables of long period.

S. I. Bailey.

THE SEVENTH INTERNATIONAL ZOOLOGICAL CONGRESS

THE congress held its scientific session last week in Boston in accordance with the program that has already been published in this journal. The meetings were held in the magnificent new buildings of the Harvard Medical School and everything possible was done for the entertainment of the delegates and members. Mr. Alexander Agassiz presided, and general addresses before the congress were given by Professor R. Hertwig, of Munich, on "Neuere Probleme der Zellforschung"; by Sir John Murray, of the *Challenger* expedition, and by Professor W. K. Brooks, of the Johns Hopkins University, whose address was entitled "Are Heredity and Variation Facts?" The titles of most of the papers presented have already been printed in SCIENCE. The number of papers offered in each section was as follows: Animal Behavior, 41; Comparative Anatomy, 44; Comparative Physiology, 28; Cytology and Heredity, 46; Embryology and Experimental Zoology, 36; Entomology and Applied Zoology, 24; General Zoology, 15; Paleozoology, 21; Systematic Zoology, 20; Zoogeography and Thalassography, 30.

The addresses presented before the sections were as follows: *Comparative Anatomy:* Professor J. P. McMurrich, University of Toronto, "The Problem of the Vertebrate Head in the Light of Comparative Anatomy." *Comparative Physiology:* Professor J. Loeb, University of California, "The Chemical Character of the Process of Fertilization." *Cytology and Heredity:* Professor C. E. McClung, University of Kansas, "Cytology and Taxonomy." Professor W. Bateson, Cambridge University, "Facts limiting the Theory of Heredity." *Embryology and Experimental Zoology:* Professor A. A. W. Hubrecht, University of Utrecht, "Larval Envelopes and Fœtal Membranes in Vertebrate Embryos." Professor W. Roux, University of Halle, "Können wir die ursachlichen Wirkungsweisen der typischen Entwickelungsvorgänge ermitteln?" Dr. H. Driesch, University of Heidelberg, "The Stimuli of Restitutions." *Entomology and Applied Zoology:* Dr. G. Horváth, Hungarian National Museum, "Relations entre les faunes hémiptérologiques de l'Europe et de l'Amérique du Nord. Dr. L. O. Howard, U. S. Bureau of Entomology, "The Recent Progress and Present Condition of Economic Entomology." *General Zoology:* Professor C. O. Whitman, University of Chicago, "The Problem of Organic Development." *Paleozoology:* Professor C. Depéret, University of Lyons, "Les migrations des faunes tertiares entre l'Europe et l'Amérique." *Systematic Zoology:* Dr. Theo. Gill, Smithsonian Institution, "Systematic Zoology, its Place and Functions." *Zoogeography and Thalassography:* Dr. R. F. Scharff, Dublin Museum, "On the Evolution of Continents as illustrated by the Geographical Distribution of Existing Animals."

After visiting Harvard University on Saturday, members of the congress went to New York by way of Woods Hole on Sunday. The present week is being spent in New York City and in excursions from the city, Monday being Columbia University day; Tuesday, American Museum day; Wednesday, Cold Spring Harbor day; Thursday, New York Zoological Society day; Friday, Hudson River day; Saturday, visits to Yale University or Princeton University. The delegates and members go to Philadelphia on Monday of next week and visit the scientific and educational institutions of that city on that day and on Tuesday. On Tuesday afternoon they leave for Washington, returning to New York on Friday. On Saturday there is an excursion to Niagara Falls.

Foreign delegates and members in attendance include the following:

British Empire: Dr. Charles W. Andrews, London; Professor William Bateson, Cambridge; Professor Charles J. S. Bethune, Guelph, Ontario; S. F. Harmer, Cambridge; R. H. Johnson, Hobart, Tasmania; Rev. W. G. Marsh, Adelaide; Sir John Murray, Edinburgh; C. Tate Regan, London; Charles F. Rousselet, London; Dr. Robert F. Scharff, Dublin; Arthur E. Shipley, Cam-

bridge; Dr. J. Y. Simpson, Edinburgh; Professor J. A. Thomson, Aberdeen.

France: Professor Raphael Blanchard, Paris; Professor C. Depéret, Lyon; Baron L. Dubreton, Paris; Professor Ch. Gravier, Paris; Baron de Guerne, Paris; Dr. Gustave Loisel, Paris.

Germany: Professor Wilhelm Blasius, Brunswick; Dr. Marcellin Braun, Königsberg; Professor Valentin Haecker, Stuttgart; Professor Richard Hertwig, Munich; Dr. Richard Heymons, Berlin; Dr. Max Luehe, Königsberg i. Pr.; Professor Otto Maas, Munich; Professor Ludwig Rhumbler, Münden; Professor Hugo H. Schauinsland, Bremen.

Belgium: Professor Paul Pelseneer, Ghent.

Holland: Dr. Johannes Buettikofer, Rotterdam; Professor A. A. W. Hubrecht, Utrecht; Professor J. W. van Wijhe, Groningen; Dr. J. Versluys, Jr., Amsterdam.

Austria: Professor Ludwig von Graff, Graz; Dr. J. F. Gudenatch, Czernowitz; Dr. F. de Marassovich, Scardona, Dalmatia; Professor Alois Mrázek, Prague; Dr. Hans Przibram, Vienna.

Hungary: Professor Istvan von Apáthy, Koloszvár; Dr. Géza v. Horváth, Budapest.

Switzerland: Dr. Herbert H. Field, Zurich; Professor Otto Fuhrmann, Neuchâtel; Dr. C. Linder, St. Imier; M. B. P. Merian, Basel; M. P. Revilloid, Geneva; Professor Theophil Studer, Berne; Professor Emile Yung, Geneva.

Russia: Dr. W. Dantchakoff, St. Petersburg; K. Derjugin, St. Petersburg; Professor Evgenij P. Golovin, Kazan; Professor G. A. Koshewnikov, Moscow; Dr. A. Maximow, St. Petersburg; Dr. N. Samssonow, St. Petersburg.

Italy: Count Filippo Cavazza, Bologna; Professor Alessandro Ghigi, Bologna; Count J. A. Salinas, Bologna; Dr. J. Wilhelmi, Naples.

Norway: Miss K. Bonnevie, Christiana.

South America: Professor Emilio A. Goeldi, Para, Brazil.

Asia: Dr. J. C. Ferguson, Shanghai; Dr. S. Watasé, Tokyo.

SCIENTIFIC NOTES AND NEWS

Sir Archibald Geikie has been made Knight of the Most Honorable Order of the Bath (Civil Division).

At the Toronto meeting of the American Chemical Society, the council decided that the offices of editor and secretary should be separated. Professor W. A. Noyes, of the University of Illinois, retains the editorship of the *Journal of the American Chemical Society* and of *Chemical Abstracts,* and Dr. Charles L. Parsons, head of the Chemical Department of the New Hampshire College and secretary of the Section of Chemistry of the American Association for the Advancement of Science, has been elected to the secretaryship.

Professor J. J. Stevenson, of New York University, and Professor W. M. Davis, of Harvard University, are among the Americans who will attend the celebration of the centennial of the foundation of the Geological Society, London, which will take place at the end of next month.

The resignation of Mansfield Merriman as professor of civil engineering in Lehigh University takes effect on August 31. After this date he will devote most of his time to professional practise as a consulting engineer, his office and address being at 45 Broadway, New York.

Dr. T. W. Richards, professor of chemistry at Harvard University, having completed his work in Berlin in connection with the plan for an exchange of professors between the two universities, sailed for America from England on August 19.

Dr. George M. Kober, dean of the Medical Department of Georgetown University, sailed from Baltimore for Bremen on August 14.

Dr. Walter Wyman, surgeon general of the Public Health and Marine Hospital Service, is chairman of the International Sanitary Bureau, which meets in the City of Mexico during the first week of September next.

At the recent congress of School Hygiene in London, the committee appointed to arrange for the next congress, to be held in Paris in 1910, consists of the following members: *Great*

Britain: Professor Osler, Dr. Kerr, Mr. White Wallis and Mr. Cloudesley Brereton. *British Colonies:* Sir John Cockburn, K.C.M.G. *Switzerland:* Dr. F. Zollinger (Zurich). *France:* M. Sigalas (Bordeaux), Professor Lefevre (Lille), and Professor Chabot (Lyons). *Belgium:* Dr. Decroby. *Russia:* Professor Chlopine. *Portugal:* Professors Saccadura and Curry Cabral. *United States:* Dr. Walcott, Dr. Gulick, Professor Da Costa.

DR. J. WALTER FEWKES, of the Bureau of American Ethnology, will undertake the work of excavation, preservation and repairs in connection with the cliff dwellings and other prehistoric ruins in the Mesa Verde National Park, Colorado. The Mesa Verde National Park was created by act of congress approved June 29, 1906. It is on the border of the Montezuma valley, just south of the ancient Montezuma road, and contains some of the best preserved relics of the prehistoric cliff dwellers in the country. Dr. Fewkes is to have the direction of the scientific work of unearthing and preserving the Mesa Verde ruins and an adequate sum has been allotted by the Interior Department for the purpose. He will proceed to Colorado after the completion of extensive excavations at Casa Grande, Arizona. This work is undertaken jointly by the Department of the Interior and the Smithsonian Institution.

MR. E. W. BERRY is engaged in the study of the paleobotany of the Coastal Plain deposits under the auspices of the U. S. Geological Survey.

MR. H. B. KUMMEL, state geologist of New Jersey, and Mr. M. L. Fuller, of the U. S. Geological Survey, have completed an extended review of the Cretaceous, Tertiary and Pleistocene formations of New Jersey, in connection with the cooperative investigations and correlation of the Atlantic and Gulf Coastal Plain deposits by the United States and the various State Surveys under the direction of Mr. Fuller.

AN investigation of the maximum glaciation of the Sierra Nevada is being made by Willard D. Johnson, geologist of the United States Geological Survey, who will this year complete a study along the full length of the east flank of the range, including a bordering zone of the Basin ranges, and will also make a reconnaissance in Carson Valley at the extreme northern end of the High Sierras.

DR. ANKERMANN, assistant in the Berlin Museum of Ethnology, will in October undertake explorations in Kamerun, for which the state has made a grant of 20,000 Marks.

AT the fortieth annual meeting of the Canadian Medical Association to be held in Montreal from September 11 to 14, under the presidency of Dr. Alexander McPhedran, Toronto, Dr. Davy Rolleston, London, will deliver the address in medicine; Dr. Ingersoll Olmsted, Hamilton, the address in surgery, and Dr. J. George Adami, Montreal, the address in pathology.

THE Joule studentship of the Royal Society has been awarded to Dr. T. H. Laby, of the University of Sydney, now of the Cavendish Laboratory, Cambridge, for an investigation of the conditions of condensation and supersaturation of vapors other than steam.

PROFESSOR WALTER BALDWIN SPENCER, F.R.S., professor of biology in the University of Melbourne (formerly scholar of Exeter and fellow of Lincoln, Oxford), has been elected to an honorary fellowship at Exeter College.

ON the recommendation of the council of the Royal College of Physicians the Baly medal was awarded to Ernest H. Starling, M.D., F.R.C.P., F.R.S., Jodrell professor of physiology, University College, London, as having preeminently distinguished himself in the science of physiology.

THE Keith prize (a gold medal and £50) for the biennial period 1903–5 has been awarded by the council of the Royal Society of Edinburgh to Thomas H. Bryce, M.A., M.D., for his two papers on the histology of the blood of the larvæ of *Lepidosiren paradoxa,* published in the *Transactions* of the society within the period.

PROFESSOR ERNEST EVERETT BOGUE, head of the department of forestry of the Michigan Agricultural College, died at Lansing, Mich., on August 19, at the age of forty-three years.

On or about September 11, 1907, an examination will be held by the Civil Service Commission to secure eligibles from which to make certification to fill three vacancies in the Naval Observatory, Washington, D. C., in the position of miscellaneous computer, and one vacancy in the position of assistant at $1,000 per annum. Miscellaneous computers are paid by the hour, and earn from $900 to $1,100 per annum. Promotions are made from this grade without further examination to the grades of assistant at $1,200 per annum, as vacancies occur. As an insufficient number of eligibles were secured as the result of the last four examinations to meet the needs of the service, qualified persons are urged to enter this examination. Applicants should at once apply to the United States Civil Service Commission, Washington, D. C., for full information concerning the examination. Applicants can be examined at various places throughout the United States.

The first meeting of the Italian Association for the Advancement of Science will take place at Parma from September 23 to 29.

Nature states that an institute entitled the Istituto Therapeutico Italiano has been established at Milan under the directorship of Dr. Zanoni, the work of which will be the investigation of the action of new drugs, especially in regard to serumtherapy and hypodermic medication.

We learn from the journal of the American Medical Association that the Sixth International Dermatologic Congress will be held at the Academy of Medicine, New York City, from September 9 to 14. An address of welcome on behalf of the United States will be delivered by Surgeon General Rixey of the United States Navy; an address for the American universities will be delivered by Professor Ira Remsen, of the Johns Hopkins University; and an address for the medical profession of the United States by Dr. Joseph D. Bryant, president of the American Medical Association. Papers will be read by some of the most famous European dermatologists, including Professor R. Campana, Rome, Italy; Dr. Z. Falcao, Lisbon, Portugal; Dr. Vinetta-Bellaserra, Barcelona, Spain; Dr. L. Brocq, Paris; Dr. Unna, Hamburg, Germany; Dr. M. Oppenheimer, Vienna; Professor E. Kromayer, Berlin; Professor E. Hoffmann, Berlin; Dr. A. Buschke, Berlin; Drs. Hallopeau and Gastou, Paris; Professor S. Ehrmann, Vienna, and numerous others. Papers are also on the program by the leading dermatologists of this country. Further details may be obtained from the secretary-general, Dr. John A. Fordyce, 80 West Fortieth Street, New York City.

UNIVERSITY AND EDUCATIONAL NEWS

At the University of Illinois, Dr. G. A. Miller, associate professor of mathematics, has been promoted to a professorship. The department of mathematics now contains three professors, one associate professor, three assistant professors, one associate, six instructors and three assistants.

Dr. Alfred E. Thayer has resigned from the chair of pathology in the University of Texas. His future address will be Asheville, N. C.

Professor F. E. Austin, who has had charge of the department of electrical engineering at the Thayer School of Civil Engineering, Hanover, N. H., will, during the coming year, have charge of the departments of physics and electrical engineering at Norwich University, Northfield, Vermont.

At the Western College for Women, Oxford, Ohio, the following changes have been made in the faculty for next year: Mary F. Leach, Ph.D., assistant in hygiene at the University of Michigan, will take charge of the advanced work in chemistry, bacteriology and hygiene; Mary D. MacKenzie, M.A. (Syracuse), will take charge of the biological department.

Mr. J. L. Simonsen, Schunck research fellow, has been appointed a junior demonstrator in chemistry at the University of Manchester.

Dr. H. Simon has been appointed professor of applied physics at the University of Göttingen.

Dr. Prenant, of the University of Nancy, has been appointed professor of histology in the medical faculty of the University of Paris.